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ERRATA.

In page 78, Prof. Duncan's description of Plate III.: fig. 4 should read fig. 4, *a*, *b*, *c*; and fig. 5, *a*, *b*, *c*, should read fig. 5.

In page 186, top line, *for* "incredible" *read* inevitable; and on line 15 from top, after "Australiam" *discard* the note of interrogation.

THE JOURNAL

OF

THE LINNEAN SOCIETY.

Anniversary Address of the President,
Professor Allman, M.D., LL.D., F.R.S.

Some Recent Additions to our Knowledge of the Structure of the Marine Polyzoa.

[Read May 24, 1879.]

In following the course which I have hitherto chosen of making the address given at our Anniversary Meeting an exponent of recent progress in certain departments of biological science, I propose in the present instance to call your attention to some additions to our knowledge of the marine Polyzoa. The shortness of the time at my disposal compels me to omit all reference to the embryological researches of which these animals have of late years been the subject; the facts which I am about to bring before you must therefore be confined to those of a purely structural character.

I. Structure of the Endoproctal Polyzoa.

Nitsche, several years ago, contributed some very important facts on the anatomy of *Pedicellina* and of *Loxosoma**. He

* Sitzungsberichte der Gessellsch. naturforsch. Freunde zu Berlin, 1869, and Zeitschr. f. wissensch. Zoolog. vol. xx. 1871.

especially called attention to the relations of the intestine, which in these genera opens, like the mouth, within the tentacular crown. This character thus becomes the index of a very distinct type of structure, in accordance with which Nitsche divides the Polyzoa into two great sections:—the Endoprocta, in which, as in *Pedicellina*, the intestine opens within the tentacular crown; and the Ectoprocta, in which, as in the great majority of the Polyzoa, it opens outside of the crown.

Besides the long-known *Pedicellina* and the more recently discovered *Loxosoma* of Keferstein and Claparède, the group of the Endoprocta now embraces the beautiful freshwater genus Urnatella, described by Leidy *; while to the same group must be referred the remarkable marine genus Ascopodaria, Busk MS., determined and carefully investigated by Busk in specimens from the 'Challenger' Expedition, but not yet made the subject of a published notice.

Loxosoma has recently been studied by Oscar Schmidt †, who believes that he finds evidence that the apparent buds in this genus are really eggs detached from the ovary and developed on the body of the parent—a view which cannot be reconciled with other observations, especially those of Nitsche and of Salensky, who found such buds borne by other buds, in which, in consequence of their immature state, no ova could have as yet existed.

Salensky ‡ has described two new species of *Loxosoma*, and has made some important observations regarding the structure of this genus. Like all the other endoproctal forms, *Loxosoma* consists of a cup-shaped body supported on a peduncle. The peduncle consists of a parenchyma and a muscular layer surrounded by a cellular layer (endocyst), which is overlain by a homogeneous membranous layer (ectocyst). Its form differs much in the two species described by him. In one (*L. Tethyæ*) the peduncle is provided with a terminal gland-like organ; in the other (*L. crassicauda*) no such organ exists. *L. crassicauda*, however, fixes itself by means of a hardened homogeneous secretion, probably produced while the animal is young, and before the disappearance of the peduncular gland. The fixation of the animal by means of such a secretion seems to be characteristic of the species; for the

* "On *Urnatella gracilis*," in Proc. Acad. Sc. Philad. vol. vii. p. 191 (1854).

† Arch. f. mikr. Anat. Bd. xii. p. 1 (1875).

‡ Salensky, 'Études sur les Bryozoaires Entoproctes," Ann. Sc. Nat. 6me sér. tome v. 1877.

other Loxosomas, which in their adult state are destitute of the gland (*L. singulare* and *L. Kefersteinii*), form no such secretion, but fix themselves by means of a sucker which terminates the peduncle.

The peduncular gland of *L. Tethyæ* is imbedded in a three-lobed terminal enlargement of the peduncle, and is composed of five or six large pyriform cells, with large nucleus. Each of these cells is prolonged into a very fine canal that unites with its fellows into a common tube, which traverses the middle lobe of the peduncular enlargement, and here opens externally by a pore.

It is a remarkable fact that even the species of *Loxosoma* which when adult do not possess the peduncular gland, have it when young. The observations of Nitsche have proved this for *L. Kefersteinii*; and Salensky has confirmed it in the case of *L. crassicauda*, and Vogt in that of *L. phascolosomatum*.

The cup-shaped body of *Loxosoma* has its margin directed obliquely to the vertical axis, thus differing from the condition of the same part in the other genera, where the margin of the cup is transverse to the axis. Its wall consists, like that of the peduncle, of a layer of nucleated cells which forms the endocyst, overlain by a homogeneous membrane which corresponds to the ectocyst.

The body-cavity, as in all the Endoprocta, is filled with a continuous parenchyma. This consists of cells apparently destitute of membrane and provided with processes, which, by their union with one another, form a network between the body-walls and the contained organs—a condition which would seem to be universal among the Endoprocta, and which separates them by a well-marked character from the Ectoprocta.

The form of the tentacles is that of a prism whose inner or oral side is provided with a ciliated groove. The outer side is composed of a layer of flattened cells, quite similar to those forming the outer layer of the body-walls. The axis of the tentacle is occupied by a parenchymatous tissue like that which fills all the body of the animal.

Large unicellular glands are described by Salensky as dispersed in the body-wall of *L. crassicauda* and *L. Tethyæ*. They are easily detected, being of a blackish colour and in considerable number. They occur chiefly at the edge of the cup and base of the tentacles, and consist of pyriform cells having their narrow ends turned towards the free surface of the body. Each cell is filled with a brownish finely granular matter enveloping a spherical nucleus.

The muscles are nearly confined to the peduncle. Only a few fibres are found under the integument in the body, into which they are continued from the well-developed muscles of the peduncle. As in all the Endoprocta, the muscles which in the Ectoprocta are engaged in the retraction of the polypide are entirely absent.

Kowalewsky believed that the digestive canal of *L. neapolitanum* had but a single orifice common to the functions of ingestion and egestion—an error which Salensky rectifies by pointing out the difficulty of observing the commencement of the œsophagus from the point of view in which this part had been sought for by Kowalewsky, namely from the ventral side of the body.

Salensky has drawn attention to a remarkable gland-like apparatus unnoticed by other observers. It has the form of two bunches of cells plunged in the parenchyma of the body, one on each side of the intestine. The cells in each bunch are eight in number, of an ovoid figure, and consist of a transparent protoplasm apparently destitute of nucleus, and surrounded by a delicate membrane. Each cell is carried on a tubular peduncle, which is a continuation of its membrane; and all the peduncles of each bunch unite into a common canal, which opens on the side of the body by a very minute orifice. Salensky regards these gland-like organs as having an excretory function, probably renal; and it is impossible not to see in them bodies of great morphological significance, which admit of a comparison with the segmental organs of worms, and have an important bearing on the vexed question of the Vermal relations of the Polyzoa.

Salensky has further succeeded in demonstrating in *Loxosoma* a central nervous system, in the form of a ganglion which is placed above the stomach, between the end of the œsophagus and the beginning of the intestine. It is of an oval shape, and gives off nerves in different directions. Most of these lose themselves in the parenchymatous tissue of the body. The largest direct themselves from the two sides of the ganglion to the dorsal part of the animal. Each of these, besides giving off many lateral branches, presents in the middle of its course a small thickening composed exclusively of nerve-cells, and, on approaching the integument, at first attenuates and then enlarges into a pyriform knot, which becomes enclosed in one of a number of tubercles which form elevations of the integument on the dorsal part of the body, on each side of the longitudinal axis. These are doubtless sense-

organs. Each carries on its summit a bunch of immovable setæ. The cavity of the tubercle is filled by the pyriform nerve-knot, which thus lies just under the surface of the integument, and is in contact with the bases of the setæ. Salensky compares these organs with the setigerous calcar of the Rotifera, and points to a close correspondence of structure between the two.

Nearly simultaneously with Salensky, and quite independently, Vogt* describes another previously unnoticed species of *Loxosoma*. It occurs parasitically in small tufts on the caudal extremity of two species of *Phascolosoma*, a genus of worms, and is hence named by its discoverer *Loxosoma phascolosomatum*.

The oblique direction of the cup-like body by which all the species of *Loxosoma* are distinguished, has suggested to Vogt a comparison to the hood of a cloak tied in front by a string. The space within the hood he names the vestibule; it contains the mouth, anus, and place of exit of the generative organs.

The peduncular gland observed in certain other species of *Loxosoma* is altogether absent in the adult state of *L. phascolosomatum*, though it exists in the larva. Vogt further describes setigerous papillæ which he regards as organs of sense. Unlike the similar organs described by Salensky, these are only two in number, one on each side of the body. Vogt, however, has failed in his attempts to find any trace of a central nervous system.

The mouth, which, in the form of a very wide funnel, opens into the vestibule at the base of the tentacular crown, is provided with two projecting lips, one a button-shaped prominence on the ventral side, the other, longer and hook-shaped, on the dorsal, where it projects into the vestibule.

Vogt has convinced himself that *L. phascolosomatum* is diœcious. He describes in the male a thick-walled sac, which lies in the mesial line over the stomach, and which becomes filled with spermatozoa. This communicates, by two very short canals, with two gland-like organs, which are situated one on each side of the stomach, and which he regards as testes, in whose cells the spermatozoa are generated before passing into the median seminal receptacle. He has seen the spermatozoa expelled from this receptacle into the cavity of the vestibule, and has noticed them escaping thence into the surrounding water.

* Carl Vogt, "Sur le Loxosome des Phascolosomes," Archives de Zoologie expérimentale, 1877. See also a translation and condensation of that memoir by Hincks in Quart. Journ. Micr. Sc. vol. xvii. new series.

The ovaries, according to Vogt, occupy in the female exactly the same position as the testes in the male. The ova are expelled from them one after the other, and pass into the vestibule, which may become loaded with them. Here they run through certain early stages of development, and are ultimately expelled as ciliated larvæ.

One can scarcely overlook the close correspondence between the organs here described by Vogt as ovaries and testes and those which Salensky describes as a glandular apparatus with a probable excretory function.

Loxosoma is regarded by Vogt as an archetypal form, from which that of the ordinary Polyzoa has been derived by successive modifications.

II. Hypophorella expansa.

We are indebted to Ehlers for a valuable memoir on a very remarkable burrowing polyzoon, to which he gives the name of *Hypophorella expansa* *.

He met with it on the coast of Spickeroog, where it occurred in burrows which it had formed in the thickness of the tube-wall of *Terebella conchilega*. The completely developed colony is composed of two kinds of dissimilar members or zooids. Of these the one set is destitute of intestinal canal, and is capable of only non-sexual reproduction, while the other has a developed intestinal tract, as well as sexual organs which give rise to fertile eggs, non-sexual reproduction occurring here only exceptionally. The intestineless members have the shape of long thin threads; he designates them as "Stengelthiere." The intestine-bearing members are urn-shaped, or flask-shaped, and are called by Ehlers "Nährthiere."

The filiform zooids, or "Stengelglieder," form stolons by which the colony extends itself, and on which the nutritive zooids or "Nährthiere" are borne. The starting-point of the entire colony is a thread-like Stengelglied, which is developed from the larva. From the distal or growing end of this are produced in linear order a succession of similar filiform zooids, which together form a progressive filament, which burrows between the layers of the *Terebella*-tube. The distal end of this filament thus represents the youngest, as yet undeveloped filiform zooid.

From the single members (Glieder) of this long filiform stolon

* E. Ehlers, "*Hypophorella expansa*, ein Beitrag zur Kenntniss der minenden Polyzoa," Abhandl. der königl. Gesellsch. der Wissenschaften, 1876.

(if we except the oldest or basal member and the youngest or terminal) there spring in regular order lateral shoots, by which the stolon sends out on one side a series of filiform zooids like those of which it is itself composed, and on the other the zooids which form the flask-shaped or nutritive members of the colony. Each component member of the burrowing stolon may thus carry on its distal end two opposite zooids, one of which is a filiform zooid, the other a nutritive zooid.

The filiform zooids push themselves between the layers of the tube-wall of the Annelid ; the nutritive zooids, on the other hand, perforate the inner layer, forming a circular orifice through which the animal projects its crown of tentacles into the lumen of the tube.

The component members of the stolon are dilated at their distal ends (where they carry the two opposite zooids) into a kind of flattened capsule. In the rest of their extent they present, under a low magnifying power, an obscurely ringed appearance. Each forms a completely closed tube filled with a clear non-corpusculated liquid. The wall is composed of a laminated chitinous ectocyst lined by a soft endocyst *, in which granules and fusiform nuclei lie embedded, but which shows no differentiation into distinct cells. In the capsule-like dilatations there occur peculiar structures in the form of glistening, thin, straight bands, which are stretched from one side of the capsule to the other, and at their points of attachment pass into the protoplasmic substance of the endocyst. Each of these bands contains a very distinct nucleus, but shows no further differentiation. They closely resemble muscular fibres such as are developed in the nutritive zooids; but Ehlers could obtain no evidence of contraction.

Unlike the filiform zooids, the nutritive zooids possess in most respects the typical structure of a Gymnolæmatous polyzoon. A peculiarity by which they are characterized consists in the presence of two hollow horn-like processes, which arise, one on each side, a little behind the orifice of the zoœcium. Nothing can be asserted as to the significance of these processes. Their cavity does not appear to communicate with that of the zoœcium.

The body-wall of the nutritive zooids consists of the same layers as that of the filiform zooids; the endocyst, however, is seen to

* Ehlers, on grounds which cannot be regarded as sufficient, refuses to employ the terms "ectocyst" and "endocyst," as well as "polypide," "zoœcium," and others now generally accepted by writers on the Polyzoa.

be much more distinctly differentiated into cell-territories. Embedded in its substance are oval nuclei, each of which is surrounded by a small area of protoplasm, from which fine filiform off-runners pass out to unite with neighbouring ones. We thus obtain the appearance of a set of stellate cells united by their radiating extensions, and believed by Ehlers to undergo slow changes of form. Ehlers believes these to be of the same nature as the stellate cells which Claparède* has observed in the walls of the marine Polyzoa, and to which he has referred the canal-system noticed by Smitt† in the body-wall of *Membranpora pilosa*. Similar cells have been described by Nitsche in the marine Polyzoa.

In the completely retracted state of the polypide the appearance of a radially striated circular disk, perforated in the centre, may be seen a little within the orifice of invagination stretching across the tentacular sheath in the manner of a diaphragm. In the exserted state of the polypide this appearance is seen to be due to folds in the wall of the tentacular sheath; and this part of the sheath will then be found to form a transparent, short, cylindrical neck with longitudinal ridges.

It will thus be seen that the great interest of Ehlers's memoir consists in its making known to us a type of Polyzoa in which there is expressed a strongly marked dimorphism of the zooids with distinct functions allocated to each of the two forms which thus make up the complete colony.

* Claparède, "Beiträge zur Anat. und Entwickel. der Seebryozoen," Zeit. f. wissens. Zool. 1871.

† Smitt, "Om Hafs-Bryozoernas utveckling," Œfversigt, 1865.

On the Thorax of the Blow-fly (*Musca vomitoria*).

By Arthur Hammond, F.L.S.

[Read June 19, 1879.]

(Plates I. & II.)

General Remarks and Descriptive Anatomy.

The following observations on the structure of the thorax of the Blow-fly embody a portion of the results obtained from a series of investigations conducted by myself at different times within the last few years on the thoracic structure of insects generally, and are offered to the Society with some diffidence.

Some time ago, on attentively considering the phenomena of wing-development in that common pest of our cellars and kitchens, the Cockroach (*Blatta orientalis*), I was induced to form the opinion that there exists in the prothorax of this insect parts which, however disguised, are the true homologues of the wings on the succeeding segments. My present object, however, is to submit such evidence as appears to me to bear upon the problem of the limits of the several segments of the connate thorax of the Diptera as exemplified in the insect which gives the title to this paper. So far as I am aware, our knowledge upon this subject has been confined to the statement that, in common with the two other orders of the Lepidoptera and Hymenoptera, the thorax of the Diptera consists mainly of the central portion of the thoracic region greatly enlarged at the expense of the other two. No definite attempt though has been made to fix by any process of reasoning the boundary which separates one of these segments from the other. According to M. Audouin, referred to by Newport *, "The parts capable of demonstration in each segment are:—on the upper or dorsal surface, the *præscutum*, *scutum*, *scutellum*, and *postscutellum*; on the inferior or pectoral surface, a single piece, the *sternum*, and on the lateral, two pieces, the *episternum* and *epimeron*, on each side; in addition to which there are also two evanescent pieces, which are of considerable size in some species, but scarcely distinguishable in others. These are the *paraptera*, portions of the thorax not articulating with the

* Article "Insecta," Cyclop. of Anat. & Physiol., p. 911, where Newport summarizes from M. Audouin, Ann. d. Sci. Nat. vol. i.

sternum, but with the episternum anterior to each wing, and the *trochantin*, articulating with the epimeron and coxa of the leg —the paraptera of the prothorax being, according to Audouin, absent."

These parts constitute the external casing of each thoracic segment exclusive of the appendages, viz. the wings and the legs, and of the internal process known as the entosternum. Of those on the dorsal surface the scutum is the most prominent piece, and to it, in the alary segments, the articulations of the wings are affixed. In front of it is the præscutum, forming the anterior boundary of the segment, and generally bent downwards to form the horny partitions between the segments known as the phragmata. Following the scutum is the scutellum, a prominent portion of the thoracic skeleton, to which also, in conjunction with the scutum, the membranous portions of the wings (the alulets of the Diptera and Dyticidæ) are attached. Lastly, we have the postscutellum, which, like the præscutum, is generally bent downwards to form the phragma. These four pieces were regarded by Audouin* as the dorsal portions of four subsegments or annuli, of which the pectoral portions are less easily demonstrable on account of their being frequently confluent and not nearly so greatly developed. The parts forming the pectoral surface have been already sufficiently alluded to for my present purpose in the quotation from Newport. Although I cannot indorse the whole series of relations thus indicated by Audouin, and typically exemplified in the structure of the Dyticidæ, the general correctness of his views is evidenced to my mind by the fact that on those chief points which separated him from Macleay †, Burmeister ‡, Westwood §, and Newport ||, to which I shall again have occasion to refer, I find the interpretation which Audouin has put upon these questions the more consonant with my own.

Where the separation of the three thoracic segments is distinct, as, for instance, in the Coleoptera, the determination of the limits of each is a matter of little difficulty. Where, however, on the contrary, they are more or less connate, as in the Hymenoptera, and especially in the Diptera, the difficulty is proportionally increased. In the former case this is illustrated by the fact of the dispute which raged over the question as to whether the piece

* Ann. d. Sci. Nat. tom. i. p. 118 (1824.)

† Zoological Journal, vol. v.

‡ 'Manual of Entomology,' translated by W. E. Shuckard.

§ Introduction, vol. ii.

|| *Op. cit.*

called by Kirby * the collar was a portion of the prothorax or of the mesothorax, a question which is, I believe, generally now regarded as settled in the former sense. The different plates of which the thorax is composed can be conveniently studied by viewing them in their different aspects as seen from a dorsal, ventral, or lateral, an anterior or a posterior point of view, as the case may be. Let us first look at the thorax from an anterior point of view, as seen on removal of the head. Surrounding the cephalothoracic foramen on the dorsal surface is a slightly thickened margin, the tergum of the prothorax (Burmeister's pronotum †). A pair of rami project from it. On either side of this are two small plates, bounded inferiorly by the coxa and posteriorly by the anterior thoracic spiracle; these are the lateral plates of the prothorax, Audouin's episterna. The cephalothoracic foramen is bounded inferiorly by two plates, which Mr. Lowne ‡ has called condyles, regarding them as parts of the last subsegment of the head. From this opinion, however, I must dissent, as I shall have occasion hereafter to show §. Between the condyles is a small plate forming a peculiar organ, which he has called the cephalo-sternum, also looked upon by him as parts of the last cephalic subsegment. All these parts are indicated in my figure 5, Pl. I. Let us now turn to the dorsal surface. Here we find at its anterior angles two prominent portions, which in many species are somewhat lighter in colour than the surrounding integument; they are not marked off by distinct sutures, but their extent is sufficiently indicated by their colour and their protuberance. Burmeister (*op. cit.*) gives them the name of humeri, and says they are the same as his pronotum ‖. Lowne apparently does not notice them, or regards them as part of the mesonotum; for, speaking of the anterior spiracle, he says (*l. c.* p. 72), "The mesothoracic tergum reaches over its superior margin and joins the prothorax in front of the spiracle."

It will be evident from a consideration of my figure 6, Pl. I.,

* 'Introd. to Entomology,' vol. iii. p. 548.

† Burmeister's terms, pro-, meso-, and metanotum, as applied to the entire dorsal surface of the respective segments, appear to supply a defect in Audouin's nomenclature, and will be used in the course of this paper as occasion requires, as also their opposites, viz. pro-, meso-, and metasternum.

‡ B. T. Lowne, 'The Anatomy of the Blow-fly' (Lond. 1870).

§ *Posteà*, p. 28.

‖ Shuckard's translation, p. 82.

that the part here referred to as overreaching the spiracle, and described as part of the mesothoracic tergum, is none other than Burmeister's humerus. I shall give reasons for thinking that Burmeister's view is the correct one*. The anterior portion of the dorsal surface is formed by a rectangular plate, the anterior angles of which are cut off by the humeri. In front it extends almost to the margin of the cephalothoracic foramen, its central portion being only separated therefrom by the narrow ring of the prothorax. Behind the humeri it extends the whole breadth of the dorsal surface, and is bounded behind by a straight transverse suture just in front of the articulation of the wings. From the circumstance that this piece is distinctly marked off from the following portion by a very evident external furrow and internal ridge, and, moreover, from the fact that it lies wholly in front of the articulation of the wings, I believe that it is the homologue of that part which in the Coleoptera especially is seen to occupy a similar position, viz. the præscutum, though in this order, as illustrated chiefly in the metathorax, it is bent inward to form the mesophragma. Following the præscutum is the large dorsal plate, the scutum, to which, as in all other insects, the wings are attached; and this is again followed by the prominent and subtriangular scutellum, to which belong the alulets. These parts are shown in my figure 1, Plate I.

We will now look at the thorax from a lateral point of view as illustrated in Plate I. fig. 6. We here notice first the parts already mentioned, and in addition the following, viz. first, the anterior spiracle immediately behind the humerus, which is followed by a large subquadrangular plate, bounded in front by the spiracle, above by the præscutum, beneath by the sternum, and behind by a smaller plate to be presently described. Mr. Lowne (*l. c.*) has called this piece the episternum; but although its relation to the sternum would seem to justify this appellation, there are yet circumstances which seem to me decidedly to remove it from the piece so designated by Audouin. It will be noticed that, like the præscutum, it is wholly and entirely anterior to the wing-socket, the latter being situate behind its superior posterior angle; and in this important respect it differs entirely from the piece which in all the Coleoptera I have been enabled to identify with Audouin's episternum. It appears to me probable that this plate is

* *Posteà*, p. 22.

M. Audouin's parapteron rather than his episternum. A similar difficulty attends the identification of corresponding portions of the thoracic casing of the Lepidoptera and Hymenoptera, whose conformation in many other respects runs somewhat parallel. Behind this comes a succession of two or three smaller pieces, extending beneath the wing, and perhaps doubtfully distinct from each other. The first of these only requires special notice, as it is this piece which I look upon as Audouin's episternum. It will be seen that it, too, may justly dispute the title with the piece in front of it, while its situation *under* the wing brings it more into harmony with the piece described by Audouin under the same name, and by Chabrier* under that of "clavicule scutellaire" in the mesothorax and "plaque fulcrale" in the metathorax respectively, the anterior superior angle running up in a point under the wing-socket, which I regard as Chabrier's "appuis de l'aile." The remaining pieces of the series extend between the alulet and the posterior spiracle. Their precise relations I can say little about, save that, in common with other parts forming the posterior surface of the thorax, I purpose to show that they belong to the meso- and not to the metathorax; the last of them is Lowne's lateral plate of the metathorax. There yet remain two pieces seen in profile, viz. the sterna of the meso- and metathoracic segments, as they are regarded by Lowne. This designation is unquestionably correct as regards the first, which is a large rectangular plate forming the greater portion of the ventral surface, and marked by a groove in the mesial line; but with respect to the second I shall give reasons for thinking that this also is mesothoracic and not metathoracic†. It will be observed here that it is bounded superiorly by the posterior spiracle, where it is broadest. Towards the mesial line it is much contracted, and passes between the intermediate and posterior coxæ; a portion of its anterior border also abuts upon the sternum and another upon the episternum. The parts visible on the ventral aspect have been already mostly described. In front are seen the humeri, and between them the condyles of Lowne; then follow the anterior spiracles, the episterna of Lowne (query, Audouin's paraptera?); and between them the large sternum of the mesothorax, followed by the acetabula and coxæ of the intermediate and posterior legs; and on either side of these are

* See Chabrier, "Essai sur le Vol des Insectes," Mémoires du Muséum d'Histoire Naturelle.

† *Posteà*, p. 27.

the posterior spiracles, the plates between them and the wings, and Lowne's metathoracic sternum (?). One portion, however, has not yet engaged our attention, viz. the narrow plate between the acetabula of the anterior coxæ. This is called by Mr. Lowne the prosternum. He says*:—"It consists of a central portion and two cornua. The central portion is a long narrow plate widest anteriorly; it is grooved along the mesial line externally, and presents a slight ridge internally; posteriorly it sends a narrow plate along the edge of the mesosternum and between it and the posterior edges of the coxæ on either side. This plate becomes broader externally to the coxa, and extends along the outer edge of its articulation, reaching the lower anterior margin of the anterior spiracle, where it unites with the lateral plate of the prothorax, and terminates in a curved point in front of the articulation of the coxa near its outer anterior angle behind the condyle."

The description appears mainly correct, though I shall have occasion to differ from it in two particulars—first, the dissociation of the condyles from the central carina between the coxa, owing to their allocation in the "fifth or last cephalic segment"†; and, secondly, the association therewith of the cornua, by which I understand the narrow plate which, as stated, runs along the edge of the mesosternum, and which I believe to be Audouin's epimeron‡.

Lastly, we will look at the thorax from behind, having first carefully removed the abdomen. Some of the parts already referred to appear again. Above is seen the scutellum, on either side the posterior spiracles with the plates surrounding them, and beneath are the coxæ. In addition to these we have the two capitate organs called halteres, which, as I shall show, take the place of the posterior wings and a large surface of integument lying between them, separated superiorly by a narrow membranous conjunctiva from the scutellum, and having an emarginate contour beneath to allow a passage to the viscera. A semilunar space intervenes between its inferior margin and the lateral plates forming Lowne's metasternum, into which project two slender apodemes connected with the halteres. About the centre of its length runs the junction of the first abdominal segment with the thorax, which extends between the bases of the halteres and

* Anatomy of the Blow-fly, p. 63. † *Posteà*, p. 28.

‡ *Posteà*, p. 27 (footnote).

separates the superior or external portion from the inferior or internal.

The whole of this large surface forms Lowne's metathoracic tergum*, so that, according to his view, we have the whole of the pieces surrounding the thoracic abdominal foramen metathoracic, viz. the metathoracic tergum and the lateral and sternal plates of the same segment. That the same opinion was held by Burmeister appears from the fact that he recognizes the same plate between the coxæ as the metasternum†; and his figures on pl. xiv. of the thorax of *Tabanus bovinus* and *Myopa testacea* afford similar evidence. In assigning these plates, therefore, to the mesothorax, I am conscious that I shall differ from a weight of authority. With respect to the posterior spiracles also, I must differ from Westwood‡ in assigning them too to the mesothorax instead of to the metathorax, whilst agreeing with him in regarding the halteres as appendages of the latter segment, in opposition to Audouin and Latreille, who looked upon them as abdominal.

So much for the external integument of the thorax. We must now shortly notice the internal processes which form the entosterna of the several segments. In the first place, we find the pair which are found at the posterior extremity of the prosternum and reach the lower margin of the anterior spiracles; they are referred to by Lowne§, and form, I believe, the prothoracic entosternum‖. Similar horny rami arise from the extremity of the sternum in many Coleoptera: for example, in the mesothorax of *Geotrupes stercorarius*, *Dyticus marginalis*, and *Rhizotrogus solstitialis*. The mesothoracic entosternum extends the whole length of the sternal piece as a thin triangular vertical plate, with a pair of lateral processes for the insertion of muscles. The entosternum of the metathorax arises between the posterior coxæ and is much narrower. A projecting point of integument between them represents the whole breadth of Lowne's metasternum (my mesothoracic epimeron) in the mesial line.

Now in deciding the question as to which segment any one of the parts here described belongs, we may be guided by three considerations:—

1st. The analogy presented by other insects;

* Anatomy of the Blow-fly, p. 65.

† Shuckard's translation, p. 85.

‡ Westwood's Introduction, p. 500.

§ *Op. cit.* p. 63.

‖ *Posteà*, p. 28.

2nd. The evidence derivable from developmental change ;

3rd. That obtainable from a consideration of the nervous and muscular systems.

Considerations of Analogies in divers Insects.—I may observe that the three orders of hexapod insects associated by Packard* under the name of Metabola, viz. the Lepidoptera, the Hymenoptera, and the Diptera, beside the point of resemblance pointed out by him, have this in common, viz. the excessive development of the mesothorax at the expense of the preceding and following segments. That this is broadly the case is, I believe, an admitted fact irrespective of questions at present under discussion; and it will be worth our while to consider what relation this preponderance of the mesothoracic over at least the metathoracic region bears to the development of the wings and to their effectiveness as organs of flight. Of the three orders it may be said that the Lepidoptera is that in which the size and effectiveness of the posterior wings are most nearly approximated to that of the anterior †. The posterior wings of the Hymenoptera are decidedly inferior to the anterior in size ; and it may perhaps be presumed that their efficiency as organs of flight is subordinate to and dependent upon the former, whose movements they are evidently formed to follow. Lastly, in the Diptera, the posterior wings are only found under the guise of halteres, and for purposes of flight are entirely obsolete.

Thus in these three orders we are brought, by a succession of stages, from a condition in which the size and effectiveness of the wings are somewhat equal, to one in which the posterior are atrophied, and the power of flight is entirely concentrated in the mesothorax. Let us see if we can trace a similar succession in the development of the segments themselves. If we can succeed in showing that the comparative development of the two alary segments in the Lepidoptera and the Hymenoptera is in proportion to their wing-power, as I may term it, we shall then have an *à priori* ground for thinking that the comparative development of the segments of the Diptera follows the same rule ; in fact, that the metathorax is almost as obsolete as the wings, and that nearly the whole of the thoracic region is mesothoracic.

* Guide to the Study of Insects, p. 104.

† From the absence of longitudinal dorsal muscles in the metathorax of the Lepidoptera, I incline to the opinion that even in this order the posterior wings are subordinate to the anterior.

But in order to do this we must first decide any disputed questions that may arise as to the limits of the thorax in these two orders. I believe that as regards the Lepidoptera there is no dispute as to the limits of the metathorax. In *Liparis salicis* (Pl. II. fig. 9), behind the lozenge-shaped scutellum of the mesothorax, we find the metathoracic scutum visible as a triangular space on each side, the mesothoracic postscutellum and the metathoracic præscutum both being developed inwardly; this is followed by a minute scutellum and postscutellum, the latter also developed inwardly. Thus it will be seen that though of considerably less extent than the preceding segment, the metathorax has still a very appreciable breadth to correspond with its wing-development. Turn we now to the Hymenoptera. Here we are at once met with an old and hotly-disputed controversy. Audouin* and Latreille* believed that the posterior portion of the thorax in this order is not strictly thoracic—that is, that a portion of the fifth segment of the body entered into its composition; while Macleay† was of opinion that the said portion was the scutellum of the metathorax enormously enlarged; and Westwood‡ seems also to have regarded it as thoracic §. I do not know that this question is regarded as settled even now, although the view taken by Packard ‖ is, so far as concerns the Hymenoptera, similar to Audouin's and my own; and I think the balance of opinion inclines that way ¶. It will be evident, however, on a little consideration that the decision of this question must largely affect the course of our reasoning, for if we adopt Macleay's views we shall have in the Hymenoptera a metathoracic development out of proportion to that of the posterior wings. I will therefore advance a few arguments to show that in this matter Audouin and Latreille are right as opposed to Macleay; and in the first place draw attention to the two figures illustrating different stages of the development of the pupa of the

* See Westwood's 'Introduction,' vol. ii. p. 75.

† Zoological Journal, vol. v. p. 172. ‡ *Tom. cit.*

§ Burmeister and Newport were also opposed to Audouin on this point. See Shuck. Transl. Burm. p. 235, and Newport's "Insecta," Todd's Cycl. Anat. and Physiol. p. 55.

‖ Packard's Guide to the Study of Insects, pp. 67 & 109.

¶ Subsequent to the reading of this paper, I have noticed that Sir John Lubbock and Dr. Ratzeburg take the same view. See abstract, "The Anatomy of Ants," Journ. Linn. Soc., Zool. (No. 80), vol. xiv. p. 738. I may also quote H. Reinhard as supporting a similar view, *vide* Berlin. entom. Zeitschr. 1865, p. 207.

Humble-Bee from Packard *. In the first of these the fifth segment of the body, the thoracico-abdominal segment of Newport, is seen to follow the alary segments and to be very similar to the succeeding abdominal ones, differing only from them in the form of its oblong spiracle, by which, however, it is easily and certainly recognized in the succeeding stage, where it is seen that the thoracic abdominal incisure has taken place behind it, including it with the thorax. If further evidence be required, I would point out that the Hymenoptera are not so exceptional in this matter as may be thought†, and that the Coleoptera, as a rule, if not also the Heteroptera, exhibit a similar structure. That the Coleoptera do so has long come under my notice; and I believe Audouin pointed out the same thing. If we look at the dorsal surface of *Rhizotrogus*, *Geotrupes*, or *Dyticus*, we find in either case the dorsal plate of a segment whose ventral arc has disappeared (the segment is ventrally atrophied). This dorsal plate is unmistakably the first of the abdominal series, and furnished, like all the succeeding ones, with a pair of spiracles, differing from the others chiefly in being larger. It is quite distinct from the metathorax, following, as it does, the inwardly developed and obtusely triangular postscutellum (see Pl. II. fig. 15, for postscutellum of *Rhizotrogus*). In default of its own ventral arc, however, it is thrown forward, as it were, upon the dorsal surface of the metathorax, or the ventral surface of that segment is produced underneath it so as to supply the place of the lost ventral arc. It is as if the great development of the ventral surface of the metathorax had absorbed that of the next segment. A like conformation, I believe, prevails in many Heteroptera. Newport ‡, I ought to add, has noticed a general atrophy of the fifth segment of the larva in insects, though he does not appear to have connected it with the ventral atrophy of that segment in the imago to which I have re-

* "On the Morphology of Insects," Proc. Boston Soc. Nat. Hist., Feb. 1866, p. 282, and the figures on p. 294.

† I cannot quite understand how it is that Packard seems to have ignored this fact; for, in the paper alluded to in the previous note, he says (p. 291), "The Hymenoptera differ from all other insects in having the basal ring of the abdomen thrown forward upon the thorax." The phenomenon is, I admit, not so strikingly marked in the two other orders as in the Hymenoptera; still it is, I venture to think, very pronounced, as I have endeavoured to show. Amongst the Heteroptera I would adduce the case of *Coreus marginatus* as the result of my own observation.

‡ Todd's Cyclopædia of Anatomy, "Insecta," p. 28.

ferred. In general the dorsal plate of the atrophied segment is about equally united with the thorax and the abdomen; but instances occur in which it approximates more closely to the former; and as this brings it nearer the structure of the Hymenoptera, I have illustrated it in the case of *Goerius olens* (Pl. II. fig. 13). It will be remarked that the metathoracic postscutellum, which is usually developed inwardly to form the metaphragma, is here raised to the surface, forming the triangular piece between the two halves of the dorsal plate of the atrophied segment, which, as usual, is furnished with a pair of spiracles, and is separated by a broad membranous conjunctiva from the first of the true abdominal series, its lateral margins being conterminous with the epimera of the ventral surface of the metathorax. Precisely the same thing has happened in the Hymenoptera, both petiolated and non-petiolated, only that in the former the thoracico-abdominal incisure being so much deeper and taking effect more on the dorsal surface, the union of the dorsal plate of the atrophied segment with the thorax becomes more striking, and therefore seems to have attracted exclusive attention.

The phenomenon is well seen in the Humble-Bee, of which I have given a drawing (Pl. II. fig. 6), where it will be seen how large a portion of the posterior surface of the thorax is occupied by this plate, reducing the metathorax in the mesial line at least to a mere ridge between it and the scutellum of the mesothorax, with a small triangular expansion on either side, to which the bases of the posterior wings are affixed. The section of the metathorax in the mesial line is shown in fig. 5, and it will at once be seen that, viewed in this light, that segment is now reduced to something like conformity with the subordinate character of its alary appendages. It might be expected that these organs, which are (in virtue of the hooklets by which they are united with the anterior pair) evidently formed to follow the movements of the latter and depend on them for their motive power, would require little or no provision of muscular force for themselves; and accordingly we find an almost atrophied metathorax and no muscles in it.

We now see therefore that in the two orders of the Lepidoptera and Hymenoptera the development of the segment is proportioned to the development of the wings. Surely, therefore, there is good *à priori* ground to expect that in the Diptera the same rule will hold independently of the reasons to be presently

adduced, and that we shall find the metathorax of this insect to be as obsolete as are the alary appendages it carries.

Let us see now how the view of the thoracic structure of the Hymenoptera thus advocated bears upon the position of the spiracles. Does it introduce an element of harmony into the study of this order as compared with other insects, or one of additional perplexity? and, finally, what is its effect on the location we may give to these organs in the Diptera? I gather from a passage in Westwood* that Latreille has made the observation that the metathorax in insects is never provided with spiracles. The observation is a good one, though not free from error, I venture to think, in the induction he draws therefrom, that they (and the halteres in consequence) are abdominal appendages. Of course, on his view of the Hymenopterous structure, they are excluded from the metathorax of that order inasmuch as, in his opinion also (as I have just mentioned), they occur on that portion of the body which belongs to the fifth or atrophied segment; and so far as I am acquainted, with the exception of the Diptera, there is no other order of insects in which a metathoracic spiracle may even be thought to be observable in the *imago*. By regarding, therefore, the posterior spiracle of the Diptera as mesothoracic, we shall introduce this element of agreement into the structure of the class—not indeed by thrusting it, as Latreille did, into the abdomen, that is, by removing it backward from the metathorax, but by the converse process of removing it forward to the mesothorax. We shall then have the metathorax in every order of insects devoid of a spiracle. That the posterior spiracle should be mesothoracic is absolutely essential to my argument, since it is surrounded by plates which I propose to show also belong to that segment.

But again, so far as I am acquainted, in every case where the limits of the thoracic segments are not subject of discussion, the position of the thoracic spiracles is, roughly speaking, between the segments, one pair between the pro- and mesothorax, and another pair between the meso- and the metathorax, though in some orders the latter are suppressed. Both pairs occur, for example, in the Coleoptera and Lepidoptera; one only in the Hymenoptera, viz. the anterior. I say roughly, because I think there is really no debatable ground between the segments, and that any

* Westwood's 'Introduction,' p. 500.

given portion of the tegumentary structures must belong to one or other of those between which it seems to occur; and it will, I think, be found that the spiracles are in every case more nearly approximated to the segment in front of them than to that behind. Indeed I have noticed that the largest tracheal branch of the spiracle between the pro- and mesothorax of *Acrida viridissima* proceeds immediately down the fore leg to that peculiar organ in the fore tibia which has been supposed to be connected with the sense of hearing.

From this and similar indications I think that the spiracle is always the property of the posterior surface of the segment in front of it. And this is an additional reason for thinking that the posterior spiracles of the Diptera are mesothoracic, viz. that they are thus made to occupy the posterior or postscutellar region of the segment to which they belong. That they should in the Blow-fly be surrounded by well-developed corneous plates instead of membranous integument, is only an indication of the general fact that the postscutellar region has participated fully as much as the other portions of the mesothorax in the exceptional development which the segment has received in this order.

Evidence fram Developmental Change.—In a paper read three years ago before the Quekett Microscopical Society, "On the Metamorphosis of the Crane-fly and of the Blow-fly," I took occasion to notice the dorsal appendages on the thorax of the pupa of these insects. I believe that these processes, which are indicated in my figures (Pl. II. fig. 1 and Pl. I. fig. 13), are the proper dorsal appendages of the prothorax, corresponding on that segment to the wings on the following one. The purport of their being seems to terminate with the pupa state; and in the imago their development as appendages seems to be arrested. As I endeavoured to show on that occasion, the fact of their being the serial homologues of the wing is not only attested by their position, but by the manner of their development, arising, as they do in either case, from a special imaginal disk, which, in the Blow-fly at least, had hitherto escaped notice from its minuteness.

This disk is shown in the case of the Crane-fly (Pl. II. fig. 12), where it will be seen to correspond exactly in position to those of the wings and halteres which follow it, viz. a little outside of, and posterior to, that of the corresponding leg. The corresponding disk of the Blow-fly is situated just behind the

anterior spiracle of the larva immediately under the integument, and partially surrounding the anterior termination of the main trachea. I think that in this case similarity of development is a strong argument in favour of similarity of homological relationship; and again it may be asked, if they be not the homologues of the wings, how are we to regard them? To look upon them as abnormal productions would, I submit, be contrary to the whole spirit of philosophical inquiry; and what other opinion we can form I know not. If, then, they be the proper dorsal appendages of the prothorax of the pupa, then the imaginal structures found immediately underneath them must in all probability correspond, and be prothoracic too. But these structures are the humeri to which I have had occasion to refer. Therefore, with Burmeister, I must look upon these parts as prothoracic*, and consider them as the homologues of the posterior angles of the collar of the Hymenoptera, the homologous parts in both orders being followed immediately by the spiracle.

But it is not only in the prothorax that the observation of developmental change will afford a clue to the division of the segments. In the pupa of the Crane-fly the dorsal surfaces of the meso- and metathorax are sufficiently and distinctly marked, the former being as conspicuous for its extent as the latter for its contracted dimensions; and, strange to say, their dorsal appendages are not yet recognizable as a pair of wings and a pair of halteres, but as two pairs of undoubted wing-cases similar to each other in every respect but that of size. It is only when we separate the latter pair and examine them carefully with a lens that we can persuade ourselves that the nascent organs within them are not really wings, but the familiar halteres (see Pl. II. figs. 3 & 4). They are, so far as I judge, unquestionably modified and abortive posterior wings, appendages of a metathoracic segment, however, reduced, and by no means abdominal, as was supposed by Latreille.

Again, on carefully removing the integument from the dorsal surface of the Crane-fly pupa over the posterior portion of the mesothorax, in front of its junction with the metathorax I disclosed the plate marked *ps* in the drawing of the imago (Pl. II. fig. 2), which I must therefore regard as mesothoracic. This plate is nearly horizontal in the Crane-fly; but a compa-

* *Anteà*, p. 12.

rison of the two insects convinced me that it corresponds with the upper or external portion of the vertical surface which Mr. Lowne (*op. cit.*) calls the metathoracic tergum. For this reason also, therefore, I must hold this to be a mistake, and that the external portion at least of the surface in question belongs to the meso- and not to the metathorax.

As to the Muscular and Nervous Parts.—But fully as cogent as either of the foregoing considerations is the evidence to be derived from an examination of the muscular structure. The nervous system of insects presents, to some extent, the repetition of parts observable in the integument. There is generally in the larva a pair of ganglia with corresponding nerves for each segment. Owing, however, to the concentration of the nervous centres in the thorax of the imago (a concentration which, in the Diptera, is carried to an extreme point), and their consequent fusion into one large nervous mass, it is less adapted to the study of homological relations than the muscular structure. The latter, however, appears to me so obvious and so comparatively easy a means of discrimination, that any diagnosis of external relations that does not take it somewhat into account must of necessity be *pro tanto* imperfect. The subcuticular muscles of larvæ present a very uniform repetition. Each segment has its own set of muscles distinct from those preceding and following it. I will not say that such a thing never occurs as the existence of a muscle extending across two or more segments, for I know at least of one instance in which this certainly appears to be the case*; still, as a rule, observable not less in the imago than in the larva, each segment is provided with its own muscles; and the connate condition or any approximation to it of two or more segments is not, so far as I know, accompanied by any fusion, either real or apparent, of their respective muscles.

To illustrate this, it will be necessary to mention that the thoracic muscles of insects assume two different principal directions †, a longitudinal and a lateral or vertical one. The former occupy

* This occurs in the larva of the Crane-fly; and a similar instance is mentioned in Sir John Lubbock's paper "On the Muscles of the Larva of *Pygæra bucephala*" (Trans. Linn. Soc. vol. xxii. p. 174), being that marked No. 2 in the first Plate attached thereto.

† For a more complete account of the muscular structure of the thorax, see "Essai sur le Vol des Insectes," par J. Chabrier, in Mémoires du Muséum d'Histoire Naturelle, p. 410.

the central portion of the thoracic cavity towards the dorsum, and are chiefly conspicuous in the alary segments, and (with the exception of the Libellulidæ) more especially of such insects as are remarkable for their power of flight, in the production of which, as is shown by Chabrier, they are chiefly instrumental. They fall in two divisions, one on either side of the mesial line, as may be seen in Plate I. figs. 8, 10, & 11, and in Plate II. figs. 5, 10, & 11. They extend from the præscutum to the post-scutellum of the segment to which they belong, in every insect with which I am acquainted, and are the "muscles dorsaux au abaisseurs des ailes" of Chabrier, the recti dorsales of the larva.

In the Coleoptera, where the thoracic segments are unmistakably distinct and the phragmata well developed, their attachments are equally clear; here, however, they are chiefly confined to the metathorax, as the faculty of flight in those insects resides in that segment. In *Acrida viridissima* we have an example where that faculty is resident in both segments; and accordingly we find that the longitudinal muscles are present in both (see Pl. II. fig. 11); and though the two alary segments are much more intimately united in this insect than they are in the Coleoptera, the two sets of muscles are perfectly distinct, the length of each being coextensive with the limits of the segment to which it belongs.

In the Lepidoptera the same rule holds. The anterior wings of these insects would appear to be the chief agents of flight; for we find the dorsal longitudinal muscles confined to the mesothorax, the vertical ones only being found in the succeeding segment. They extend from the præscutum to the postscutellum, from the pro- to the mesophragma, both of which partitions are well marked. See Pl. II. fig. 10, which represents a section of the thorax of *Liparis salicis*.

In the Hymenoptera a somewhat singular conformation exists, which was first, I believe, pointed out by Macleay. The mesothoracic postscutellum is detached in the mesial line from the scutellum, and only remains attached by its lateral extremities, so that the narrow rim of the metathorax follows immediately upon the scutellum of the preceding segment. Nevertheless that the detached septum thus formed is the postscutellum of the mesothorax is evidenced, as Macleay says, by the fact that when

the meso- is separated from the metathorax, it always comes away with the former. In the mesial line it projects far backwards into the posterior portion of the thoracic cavity so as to leave but little space between it and the posterior wall, which, as I have said, is formed by the dorsal plate of the fifth segment. Thus the longitudinal muscles of the mesothorax, which are the only thoracic longitudinal ones developed, pass from it to the præscutum, across the minute groove of the metathoracic tergum and the cavity of the mesothoracic scutellum, as may be seen in Plate II. fig. 5, which represents a longitudinal section in the mesial line of the thorax of the Humble-Bee. There is no fusion of the muscles of the two segments. The mass of muscles which nearly fills the united cavity of three segments belongs but to one of them, viz. the mesothorax; the metathoracic muscles, both longitudinal and vertical, being no longer required, are altogether obsolete.

Now for the application, so far as the longitudinal muscles are concerned. Plate I. fig. 8 shows the longitudinal muscles of the Blow-fly. They are seen to extend from the mesothoracic præscutum in front to that vertical posterior surface which Burmeister and Lowne regard as the metathoracic tergum, but which, I venture to submit, is again, as it has been shown to be in all previous cases, the mesothoracic postscutellum, the mesophragma, and not the metaphragma. If it be otherwise, we shall have what I can find no other instance of, viz. a commingling of the principal muscles of two segments into one homogeneous muscular mass.

Again, be it observed from Plate I. figs. 8 & 11, that although the longitudinal muscles extend in the mesial line almost to the verge of the cephalothoracic foramen, they have not sufficient breadth to reach the anterior angles where the humeri are situated. It will be obvious that if this were the case, I could no longer hold the humeri to be prothoracic; but as it is, the avoidance by the mesothoracic muscles of these portions of the integument is, I submit, significant of the correctness of my view.

Further, let us see what may be learnt from a study of the transverse or vertical muscles of the thorax, proceeding on the assumption, warranted by general observation, that none at least of the principal of these can have their origin in one segment and

their insertion in another*, and that where two segments are concerned there is sure to be more or less repetition of the muscles presented to view.

Let us glance for one moment at the muscular structure of *Æshna grandis.* This insect is remarkable for its power of flight, and yet, contrary to the general rule, the longitudinal muscles are almost obsolete, the deficiency being made up by the number and high organization of the vertical ones. The alary segments are not very clearly separated externally, but internally an inspection of these vertical muscles shows clearly that the united cavity they occupy is formed of two segments. After removing the two principal masses which towards the mesial line are attached to the bases of the wings, and which obstruct the view of those behind, we find a number of others which have their insertions formed in a peculiar and very beautiful manner by a round plate, or "cupule" as Chabrier calls it, to the concave surface of which the muscles are attached, while from the other proceeds a tendon to the point requiring motion. These muscles, with the exception of the last, are repetitions in two sets, 1 2 3 4, 1 2 3 4 (see Pl. II. fig. 14), showing the existence of two segments.

But there is no such repetition in the vertical muscles of the

* If there be any doubt felt as to the correctness of such an assumption, let us look a little further into the matter. Passing by my own observations on the point, though the statement is founded mainly upon them, I may refer to the figures of Lyonet, in his Anatomy of the Larva of *Cossus ligniperda,* and to Sir John Lubbock, "On the Larva of *Pygæra bucephala,*" Linn. Trans. vol. xxii. p. 173. Of the following corresponding lateral muscles in the two insects, viz.

α	Lyonet	= 37 ? and 38	Lubbock,
β	,,	= 49 and 50	,,
γ	,,	= 46, 47, and 48	,,
δ	,,	= 51	,,
ζ ?	,,	= 33 and 34	,,
θ ?	,,	= 35 ? and 36	,,
m	,,	= 40	,,
n	,,	= 43	,,

only the four marked thus (?) appear to offer a shade of doubt in this respect; and these cases are indeed, as I may say, doubtful ones. The question is not exactly whether they actually cross the border-line between the segments, but rather whether they are attached by one extremity thereto, and that, in the case of $\theta = 35$, only in a partial sense, the anterior fasciculi only being in question.

Fly, in which three principal masses are observable (Pl. I. figs. 9, 10, & 11), the anterior being the "sternali dorsaux" of Chabrier, and the posterior his "costali dorsaux"; the intermediate one I am uncertain about.

Inasmuch, therefore, as there is no repetition, the muscles, I submit, are those of one segment. Again, the central mass of vertical muscles connects the anterior portion of the mesothoracic scutum with the plate that Burmeister and Lowne call the metasternum. How can this be? There is only one answer. This plate is not, as they regard it, metathoracic*.

In addition to its muscular connexion with the mesothoracic scutum, I would suggest the following reasons for regarding it as the mesothoracic epimeron. We have seen from Mr. Lowne's account (*op. cit.*) that the prothoracic sternum sends out posterior to the coxæ two "cornua," which, passing outwards, expand into small plates that surround the acetabula of the fore legs and reach as far as the anterior spiracles (see Pl. I. fig. 2), the condyles, and the lateral plates of the prothorax. In a perfectly similar manner it appears to me that the mesothoracic epimera, if I may be allowed so to call them, originate from the posterior extremity of the sternum of that segment, and, passing outwards, surround the acetabula of the intermediate legs, and are there brought into contact with the spiracles, the sternum of the segment, and the posterior lateral plates of Lowne, Audouin's episterna. It is a character of Audouin's epimeron that it is always in connexion with the coxa, and articulates with the sternum and episternum of the segment†. Again, the posterior mass of vertical muscles, the costali dorsaux of Chabrier, unites the posterior portion of the mesothoracic scutum with Lowne's lateral plate of the metathorax just above the posterior haltere. This, too, appears inconsistent with the rule of muscular structure adverted to; and I must regard this plate also as part of the mesothorax, though I am unable to identify it certainly with any of Audouin's pieces; I think it probably forms part of the postscutellum, together with the central portion between the bases of the halteres.

Thus it appears to me that the analogy of other insects, the

* *Anteà* p. 13.

† Cyclop. of Anat. and Physiol., "Insecta," p. 48, for which reason also I regard the above-mentioned cornua as the epimera of the prothorax, as stated *anteà* p. 14.

phenomena of development, and the study of the muscular system, all combine to show that the thorax of the Diptera as illustrated in this insect is almost exclusively mesothoracic. Nothing is left of the metathorax except the halteres, a narrow strip possibly along the posterior edge of the mesothoracic epimera, the coxæ, and the entosternum of the segment, to which must be added the posterior surface of the mesophragma, formed, as in many other cases, by the inversion and adherence together of the two layers of integument of the postscutellum of the one segment and the præscutum of the other. The only remnants of the metathoracic muscles which exist are two thin slips which, originating at the posterior surface of the mesophragma close to the halteres, pass downward and forward, and are inserted in the entosternum of the metathorax. The fact of their being so inserted proves that they are metathoracic muscles. The further fact of their originating on the posterior surface of the mesophragma again shows that that posterior surface is metathoracic, as just stated, and that the cavity of the metathorax, if cavity it can be called, is posterior to this surface and continuous with that of the abdomen. Again, if a further proof be sought, it may be found in the projection into that cavity of the two slender apodemes of the halteres before referred to.

Lastly, I may add a few words on the light the muscular system throws on the boundaries of the prothorax. We have seen how the longitudinal muscles of the mesothorax avoid the humeri. I would now point out, from Pl. I. figs. 9 & 11, that the vertical muscles do the same, not being sufficiently advanced anteriorly to reach them; while, on the other hand, a muscle of considerable size, which, passing as it does to the anterior coxa, must, I submit, be regarded as prothoracic, takes its origin from the same parts (see Pl. I. fig. 12). Furthermore, that the condyles form part of the prothoracic segment *, I must conclude from the observation that a pair of muscles connect their interior surfaces with the rami which represent the entosternum † at the posterior inferior margin of the segment behind the coxæ; they represent probably the anterior lateral processes of the prosternum of the Coleoptera.

I shall only further remark that truth is frequently only to be

* *Anteà*, pp. 11 and 14. † *Anteà*, p. 15.

arrived at through a series of errors, and that I can scarcely hope that all my observations will prove exceptions to the general rule.

DESCRIPTION OF THE PLATES.

All the illustrations are necessarily much magnified.

The parts of the thorax are designated in accordance with my own view of their relations, except where indicated in brackets, and are lettered the same throughout the series of figures, viz.:—

h. The humerus. *prs.* The præscutum of the mesothorax.
scm. The scutum of the mesothorax.
scm'. „ „ metathorax (not found in the Blow-fly).
scl. The scutellum of the mesothorax.
scl'. „ „ metathorax (not found in the Blow-fly).
con. Lateral processes of the prosternum (Lowne's condyles).
epis. The lateral plates (episterna) of the prothorax.
sp. The anterior (prothoracic) spiracle.
sp'. The posterior (mesothoracic) spiracle.
sp.* The spiracle of the fifth segment.
cox, *cox'*, *cox''*. The anterior, intermediate, and posterior coxæ.
par. The parapteron (Lowne's anterior lateral plate of the mesothorax).
epim. The epimeron of the prothorax (Lowne's cornua).
st. The sternum of the prothorax.
st'. „ „ mesothorax.
epis'. The episternum of the mesothorax (Lowne's posterior lateral plate).
x. Uncertain (Lowne's lateral plate of the metathorax).
epim'. The epimeron of the mesothorax (Lowne's metasternum).
ps. The postscutellum of the mesothorax (in Pl. I. Lowne's dorsal plate of the metathorax).
ps'. The postscutellum of the metathorax (not found in the Blow-fly).
lm and *vm.* Longitudinal and vertical muscles of the mesothorax of the Blow-fly (Pl. I.).
mes. Mesothorax (Pl. II.); *met.* Metathorax (Pl. II.).
i. The dorsal plate of the fifth segment (Pl. II.).
m. The longitudinal muscles of the mesothorax (Pl. II.).
m'. „ „ metathorax (Pl. II.).

PLATE I.

Fig. 1. Dorsal surface of thorax of Blow-fly.
2. Ventral surface of ditto: *f*, the cephalothoracic foramen; *ac*, acetabulum of fore leg; *hal*, the haltere.
3. Entosterna of meso- and metathorax, side view.
4. The same, from above.

Fig. 5. Anterior view of prothorax; *pr*, pronotum.

6. Lateral view of thorax.

7. Posterior view of ditto: *ps*, postscutellum of the mesothorax; *mph*, mesophragma formed by the united postscutellum of the mesothorax and the præscutum of the metathorax†; *al*, alulet; *mm*, metathoracic muscles proceeding to metathoracic entosternum; *ap*, apodeme of haltere; *z*, narrow margin, probably remains of lateral plate of metathorax; *j*, line of junction of thorax and abdomen.

8. Longitudinal vertical section of thorax in the mesial line, showing longitudinal muscles: *prov*, the proventriculus followed by the chyle-stomach.

9. The same, with the longitudinal muscles removed, showing:—vm^1, vm^2, vm^3, the vertical muscles; *pm*, prothoracic muscle inserted in the fore coxa; *mm*, metathoracic muscle to entosternum.

10. Transverse vertical section of thorax, showing muscles.

11. Horizontal longitudinal section of ditto.

12. Internal view of a portion of the thoracic cavity, showing:—*pm*, the muscle of the fore coxa; *m**, small muscles connected with the wing beneath the parapteron. A strong process, *g*, of the præscutum is seen to bridge across the humerus without touching it.

13. The pupa of the Blow-fly: *o*, the compound eyes; *pa*, the prothoracic dorsal appendages.

Plate II.

Fig. 1. Pupa of Crane-fly. Anterior portion, showing:—*pa*, the prothoracic appendages; *mes*, the posterior portion of the mesothorax (upon removing the integument at this part, the postscutellum of the mesothorax (*ps*, fig. 2) of the imago is revealed); *met*, the metathorax; *w*, *w'*, the anterior and posterior wing-cases.

2. The thorax of the Crane-fly. The plate, *ps*, between the halteres, corresponding to the posterior wall of the thorax of the Blow-fly, is shown to be mesothoracic, *i. e.* the mesothoracic postscutellum as it is developed beneath the mesothoracic integument of the pupa.

3 & 4. The anterior and posterior wing-cases of the pupa of the Crane-fly. The haltere is shown in course of development within the latter.

5. Longitudinal vertical section of the thorax of the Humble-Bee: *ps*, the postscutellum of the mesothorax, to which the muscles, *m*, are attached.

6. The thorax of the same, showing the reduced extent of the metathorax: *col*, the collar; *a*, its posterior angle; *sp**, spiracle of fifth segment.

7 & 8. Figures adopted from Packard, showing the two stages in the development of the pupa of the Humble-Bee. In the latter the thoracico-abdominal constriction is seen to include the fifth segment (*i*) with the thorax: *sp**, the spiracle of the fifth segment.

9. The thorax of *Liparis salicis*.

10. Longitudinal vertical section of the thorax of *Liparis salicis*: parts the same as in fig. 5.

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† Consult *anteà*, p. 28.

Fig. 11. Ditto of *Acrida viridissima*, showing two sets of longitudinal muscles.

12. The marginal disks of the Crane-fly attached to the nerve-centres: l', l', l'', those of the legs; *pa*, that of the prothoracic appendage; w, w', those of the wings and halteres.

13. Thorax of *Goerius olens*, showing the dorsal plate of the fifth segment, *i*, attached thereto and separated from the succeeding abdominal ones: *ps'*, the postscutellum of the metathorax.

14. Vertical thoracic muscles of *Æshna grandis*, showing a distinct repetition, 1 2 3 4, 1 2 3 4, in each segment.

15. The subtriangular metaphragma of *Rhizotrogus solstitialis* formed by the postscutellum of the segment, for comparison with the postscutellum in fig. 13.

Instincts and Emotions in Fish.

By Francis Day, F.L.S.

[Read November 6, 1879.]

During the last few years the instincts of brutes have received much attention from biologists, while those of fishes have been generally passed over. Some naturalists have not hesitated to assert that the lives of the finny tribes are destitute of the joys and sorrows generally appertaining to vertebrate animals, attributing to them an almost vegetative existence. In a work lately published in this country, Cuvier's low estimate of their intelligence has again been adopted in its entirety, although during the course of this century much information has accumulated pointing in an opposite direction. Irrespective of this, the ancients must have had a higher opinion of the finny tribes than the authors of the present time, if we are to judge from the attributes they accorded to fish.

But returning to half a century since, we find that Cuvier had no very exalted opinion of the intellect of fishes, considering that among all the vertebrate animals they show the least signs of sensibility, which of course might be expected, as they are the lowest division. Nearly or quite destitute of any voice, with immovable eyes and a fixed osseous face, their physiognomy has no play, their emotions no expression, only capable of hearing the loudest sounds, for, condemned to reside in an empire of silence, they have but small occasion for the sense of hearing. No tear

moistens, no eyelid shelters or wipes the surface of the eye, which is but an indifferent representative of that organ as existing in the superior classes of animals. Delicate sense of taste is said to be wanting, and that of smell to be but small; while feeling on the surface of their bodies is almost obliterated, due to the interposition of scales, and, in some species, even their very lips are converted to the hardness and insensibility of bone. To pursue their prey or escape an enemy is the constant occupation of their lives, determines their place of abode, and is the principal object of the diversities of form among them. Their sexual emotions, cold as their own blood, indicate merely individual wants. With scarcely an exception, fish do not construct a nest; they neither feed nor defend their offspring. The inhabitant of the waters knows no attachments, has no language, no affections; feelings of conjugality and paternity are not acknowledged by him; ignorant of the art of constructing an asylum, in danger he seeks shelter among rocks or in the darkness of profound depths: his life is silent and monotonous.

What a gloomy picture is here sketched out respecting fishes! Eager in the pursuit of prey in order to satisfy the cravings of hunger, or terrified at the approach of danger, their lives, which are said to be silent, monotonous, and joyless, would appear to be scarcely worth preserving; death itself, one would imagine, must be a happy release from a burdensome existence. But fishermen are well aware that the finny tribes are as eager to escape from danger, or avoid capture, as are the inhabitants of the earth or the frequenters of the air, which compels us to question whether their lives are so joyless as has been represented—if anger or affection are really among their unknown passions.

I will first observe upon the means possessed by fishes enabling them to demonstrate their emotions. First, we find that they are capable of erecting their dermal appendages, as scales or fin-rays, under the influence of anger or terror, similarly as feathers or hairs are erected in birds and mammals. But special expressions, as those of joy, pain, astonishment, &c., we could hardly anticipate being so well marked in fishes as in some of the superior grades of animals, in which the play of the features frequently affords an insight into their internal motions. Eyes without movable eyelids, cheeks encased with bony plates or covered with hard scales, are scarcely suitable for smiling or developing into a laugh. Ex-

ternal ears likewise are wanting. Still we perceive one very distinct expression in this vertebrate class which is absent, or but slightly developed, in many of the higher animals, namely, *change of colour**. Most of us are aware that when a fish sickens its brilliant tints become less and less, or even entirely fade away, while the same result may follow being vanquished by a foe. But when in good health and residing in suitable localities, especially during the breeding-season, their colours become vivid, and even a temporary accession of anger may cause a similar result.

The first subject for investigation is, *Are the finny tribes destitute of affections?* Here I purpose inquiring whether fish are monogamous or polygamous, whether they show signs of affection to their companions, if they construct nests, guard their nests or eggs, protect their offspring, and, lastly, if they are ever known to exhibit traits of affection for human beings. In some parts of the world, more especially in fresh waters, we have monogamous as well as polygamous fishes—the former, as a rule, not depositing so many eggs as the latter, probably for two reasons, (1) that they breed more frequently, and (2) that they generally protect their offspring. The Gouramy (*Osphromenus olfax*) at the Mauritius commences breeding at six months of age, while their fecundity is astonishing. During the breeding-season they frequent the sides of tanks, where shelter is afforded them by the grasses and weeds growing in the water. For several days they are very active, passing in and out of their grassy cover, and in some places thickening it by entangling all trailing shoots, and forming what is generally considered the spot under which the ova are deposited†. They continue to watch this place with

* It is not here held that change of colour is always due to emotional sensations. Thus Professor Agassiz observes that in young *Pleuronectoids* the embryos were very sensitive to light, both sides changing colour rapidly at will. He considers that as soon as the two eyes become situated exclusively on one side of the head, the nerve controlling the colour-cells, of what has now become the eyeless side, becomes gradually unable to act, consequently the under or blind side becomes colourless. It seems to be an almost invariable fact that the under surface in fish is less vividly coloured than the upper surface, and that such is occasioned by the influence of light; but whether such is entirely due to the action of the optic nerve is open to grave doubt, for were it so, all blind fish would be colourless; and here, again, we must distinguish between those which are sightless owing to living in dark caves, and others which are so consequent upon accidental loss of vision in their embryonic stage.

† On nest-building fishes, see Martens, Zool. Gart. 1872, pp. 107–111.

the greatest vigilance, driving away any interloping fish; and at the end of a month numerous fry appear, over which the old Gouramies keep guard many days*. M. Carbonnier, who has studied the habits of the Chinese Butterfly-fish (*Macropodus*) in his private aquarium in Paris, where he had some in confinement, observed† that the male constructs a nest of froth of considerable size, 15 to 18 centimetres horizontal diameter, and 10 to 12 high. He prepares the bubbles in the air (which he sucks in and then expels), strengthening them with mucous matter from his mouth, and brings them into the nest‡. Sometimes the buccal secretion will fail him, whereupon he goes to the bottom in search of some confervæ, which he sucks and bites for a little in order to stimulate the act of secretion. The nest prepared, the female is induced to enter. Not less curious is the way in which the male brings the eggs from the bottom into the nest. He appears unable to carry them up in his mouth; instead of this, he first swallows an abundant supply of air, then descending, he places himself beneath the eggs, and suddenly, by a violent contraction of the muscles in the interior of his mouth and pharynx, he exhales the air which he had accumulated by the gills. This air, finely divided, partly by the lamellæ and fringes of the gills, escapes in the form of two jets of veritable gaseous powder, which envelops the eggs and raises them to the surface. In this manœuvre the *Macropodus* entirely disappeared in a kind of air-mist, and when this had dissipated he reappeared with a multitude of air-bubbles like little pearls clinging all over his body.

In Asia there are several species of Snake-headed or Walking-fishes (*Ophiocephalus*). The male of the common striped form, *O. striatus*§, constructs a nest with his tail among the vegetation at the side of tanks, biting off the ends of the weeds that grow in the water. Here the ova are deposited, the male keeping guard; but should he be killed or captured, the vacant post is filled by his partner. It is a curious sight to see them with their fry swimming along near the surface of the water, the latter generally

* General Hardwicke, Zool. Journal, iv. 1829, p. 309.

† Bulletin de la Société d'Acclimatation, Paris, 1872.

‡ The same fact has been observed of the *Gasterosteus aculeatus* by Mr. Mabel, the Curator of the Weston-super-Mare Museum.

§ *Pristolepis malabaricus*, which is not amphibious, constructs a nest according to Mr. Thomas.

going in single file above them. The parents are very fierce at this period, and defend their offspring with great courage*. I have likewise personally witnessed in Canara the young of the orange Walking-fish, *O. aurantiacus*, swimming about with their parents, by whom they are protected, according to native fishermen, until they are able to shift for themselves, when they are driven away by their progenitors. The fishes enumerated as monogamous, viz. *Osphromenus*, *Macropodus*, and *Ophiocephalus*, are all amphibious Acanthopterygians and inhabitants of Asia. I will now pass on to examples taken from other localities.

Pennant† remarks that the river Bullhead (*Cottus gobio*) deposits its spawn in a hole it forms in the gravel, and quits it with great reluctance. We are told of a Russian fish, Bitshki‡, that it is one of the most remarkable of those in the Black Sea, and always occasions fever in whoever eat it, while it builds for its young a nest like a bird. The male and female unite their cares in its construction, gathering seeds and soft seaweeds, and depositing them in small holes on the shore. In this the female not only lays her eggs, but watches them carefully like a hen; and when the little ones are hatched, they remain near the mother till they are sufficiently grown to venture forth alone into the world of waters.

In South America two species of monogamous fish, termed "Hassar" and also "Hardback," of the genus *Callichthys*, have been observed to construct nests—the flat-headed form (*C. asper*) of leaves, and the round-headed kind (*C. punctatus*) of grass; in these they deposit their eggs, which they carefully cover, and both sexes watch and defend them till the young come forth. The late Dr. Jerdon§ remarked of the beautiful little *Etroplus maculatus*, an inhabitant of the streams of Southern India and Ceylon, that the eggs, which were not very numerous, were deposited in the mud at the bottom of a stream; and when hatched, both parents guarded their young for many days, vigorously attacking any large fish that passed near them. It is evident, in this case, that they must have remained in the vicinity of their eggs and watched over them until the young came forth. The Lump-sucker, *Cyclo-*

* Col. Puckle, Report on the Fishes of Bangalor.

† Brit. Zool. iii. 1776, p. 216

‡ Koht's 'Russia.'

§ Madras Journ. Lit. and Sc. 1849, p. 143.

pterus lumpus, is, according to Yarrell and others, a fish that shows attachment for its eggs. At the spawning-time the female precedes and deposits her ova among the larger algæ and in fissures of the rocks; the male shortly follows and fructifies the eggs, adhering so closely to the mass of roe that the impression is left upon the hollow surface of the shield formed by the ventrals, after which he keeps watch over the deposited ova and guards them from every foe with the utmost courage. If driven from the spot by man he does not go far, but is continually looking back, and in a short time returns. Dr. Johnston observes that the fishermen in Berwickshire believe that the male covers the spawn and remains covering or near it until the ova are hatched, and that the young soon after birth fix themselves to the sides and on to the back of their male parent, who sails, thus loaded, to deeper and more safe retreats.

Agassiz remarks* that while examining the marine products of the Sargasso Sea, Mr. Mansfield picked up and brought to him a round mass of sargassum, about the size of the two fists, rolled up together. The whole consisted, to all appearance, of nothing but gulf-weed, the branches and leaves of which were, however, evidently knit together, and not merely balled into a roundish mass. The elastic threads which held the gulf-weed together were beaded at intervals, sometimes two or three beads being close together, or a branch of them hanging from the cluster of threads. This nest was full of eggs scattered throughout the mass and not placed together in a cavity. It was evidently the work of the *Chironectes*. This rocking fish-cradle is carried along as an undying arbour, affording at the same time protection and afterwards food for its living freight. It is suggested that they must have used their peculiar pectoral fins when constructing this elaborate nest.

The well-known Tinker or ten-spined Stickleback, *Gasterosteus pungitius*, is one of our indigenous fish which constructs a nest. On May 1st, 1864, a male† was placed in a well-established aquarium of moderate size, and in which, after three days, two ripe females were added. Their presence at once roused him into activity, and he soon began to build a nest of bits of dirt and dead fibre and of growing confervoid filaments ,upon a jutting point of

* Silliman's American Journal, Feb. 1872.

† Ransom, Ann. & Mag. Nat. Hist. 1865, xvi. p. 449.

rock among some interlacing branches of *Myriophyllum spicatum*—all the time, however, frequently interrupting his labours to pay his addresses to the females. This was done in most vigorous fashion, he swimming, by a series of little jerks, near and about the female, even pushing against her with open mouth, but usually not biting. After a little coquetting she responds and follows him, swimming just above him as he leads the way to the nest. When there, the male commences to flirt—he seems unaware of its situation, will not swim to the right spot, and the female, after a few ineffectual attempts to find the proper passage into it, turns tail to swim away, but is then viciously pursued by the male. When he first courts the female, if she, not being ready, does not soon respond, he seems quickly to lose his temper, and, attacking her with great apparent fury, drives her to seek shelter in some crevice or dark corner. The coquetting of the male near the nest, which seems due to the fact that he really has not quite finished it, at length terminates by his pushing his head well into the entrance of the nest, while the female closely follows him, placing herself above him, and apparently much excited. As he withdraws she passes into the nest, and pushes quite through it, after a very brief delay, during which she deposits her ova. The male now fertilizes the eggs and drives the female away to a safe distance; then, after patting down the nest, he proceeds in search of another female. The nest is built and the ova deposited in about twenty-four hours. The male continued to watch it day and night, and during the light hours he also continually added to the nest.

The marine "15-spined Stickleback," *Gasterosteus spinachia*, affords another instance of nest-constructing fishes. The places selected for their nests are usually harbours or some sheltered spots to where pure sea-water reaches. The fish either find growing or even collect some of the softer kinds of green or red seaweed, and join them with so much of the coralline tufts (*Janiæ*) growing on the rock as will serve the purpose of affording firmness to the structure, and constitute a pear-shaped mass five or six inches long, and about as stout as a man's fist. A thread, which is elastic and resembles silk, is employed for the purpose of binding the materials together; under a magnifier it appears to consist of several strands connected by a gluey substance, which hardens by exposure to the water. In one instance the situation selected was the loose end of a rope, from which the separated strands hung at about a yard below the surface in five or six

fathoms of water, to which the materials must have been conveyed at least thirty feet. The nest, which was of the usual construction, was matted together in a hollow formed of the untwisted strands of the rope, and in it were deposited the ova in the usual way. It was watched over by the parent, who did not appear to quit his station; still instances have been observed when more than one watcher was present. When the guardian is compelled to retreat, owing to a receding tide, he returns again with the first suitable wave; and in three or four weeks the young emerge. So intent is this fish on the object over which he keeps guard, that at this time he may be easily captured, but he resents all interference with the nest; if the ova are exposed, he at once repairs the breach by dragging fresh materials into a position by which they are again concealed and protected*.

Not only will some fishes protect their nests in which are deposited the ova, but forms which do not construct any receptacle for their eggs have interesting modes of protecting them or removing them from localities where they may be exposed to danger. The Siluroid, or scaleless, also termed Sheat-fishes (*Siluridæ*), although almost unknown in the colder regions of the North, become numerous as the tropics are approached, some being marine forms, others restricted to the fresh waters. These fishes delight in muddy localities, and seek their food by means of feelers placed around the mouth, as well as by means of hearing, their air-bladder forming an acoustic organ. The marine and estuary genera of which the group *Ariina* is composed, all deposit large eggs from 0·5 to 0·6 of an inch in diameter; and while examining the fishes along the western coast of India, I found many of the males of this group with from fifteen to twenty of these large eggs in their mouths. Some of these eggs were in an early stage of development, others ready for hatching, while one example contained a young fry hatched, but having the yelk-bag still adherent. They filled the cavity of the mouth and pharynx of these male fishes. Whether the male carries these eggs about in his mouth until they are hatched, or merely removes them from some spot when danger is imminent, of course may be open to question; but it is a significant fact that in none of the

* Couch, Brit. Fishes, i. p. 182. M. Gerbe (Rev. et Mag. Zool. xvi. pp. 255, 273, 337, 1865) observes that fishes of the genus *Crenilabrus* build a nest of seaweed; here the ova are deposited; both sexes assist in its construction.

examples which I dissected could I find a trace of food throughout the intestines of the males who had been engaged in this interesting occupation*. The same phenomenon was observed in two examples of *Arius fissus* which came from Cayenne, and were presented to the British Museum†, and by Dr. Hensel in the Brazilian *Arius Commersonii*. A fish from Lake Tiberias, *Chromis paterfamilias*, has been described‡, the male of which carries the eggs in the buccal cavity, the young even remaining there some time after they have been hatched. It has been remarked of the Siluroid genus *Aspredo*, that they take care of their progeny, and the females possess appendages for the purpose of keeping the eggs attached to the belly of the mother§. Some fishes, as the Salmon, the Trout, and the Shad, have been known to discontinue feeding during the breeding-season‖. Among Batrachians we also see that the males may carry the eggs until hatched: thus, in *Rhinoderma Darwinii*, the males have an extraordinary brood-sac developed as a pouch from the throat, and extending over a great portion of the ventral surface of the animal. In this cavity a number of living tadpoles have been observed by the Spanish naturalist Jimenez de la Espada¶.

Fish, however, have other modes of showing solicitude for the welfare of their eggs, some of which I have already mentioned; but a few more instances perhaps will not be considered superfluous. In some interesting observations respecting the construction of the nest and the habits of the "Three-spined Stickleback," *Gasterosteus aculeatus***, it has been remarked that after the deposition of the eggs the nest was opened more to the action of the water, and the vibratory motion of the body of the male fish, hovering over its surface, caused a current of water to be propelled

* Day, 'Fishes of India,' p. 456.

† Lortet, Compt. Rend. 1875, lxxxi. p. 1196.

‡ Günther, Catal. v. p. 173.

§ *L. c.* p. 268.

‖ Max Weber, Arch. f. Nat. (2) xlii. p. 169.

¶ Sprengel, Zeitschrift für wissensch. Zool. vol. xxiv. part 4 (1877).

** The *Gasterosteus aculeatus*, says Baker, Phil. Trans. Roy. Soc., seek out and destroy all the young fry that come in their way, which are pursued with the utmost eagerness and swallowed down without distinction provided they are not too large. He continues that one did (on 4th of May) "devour in five hours' time seventy-four young dace, which were about $\frac{1}{4}$ of an inch long, and of the thickness of a horsehair; two days after it swallowed sixty-two, and would, I am persuaded, have eaten as many every day could I have procured them for it."

across the surface of the ova, which action was repeated almost continuously. After about ten days the nest was destroyed and the materials removed; and now were seen the minute fry fluttering upwards here and there, by a movement half swimming, half leaping, and then falling rapidly again upon or between the clear pebbles of the shingle bottom. This arose from their having the remainder of the yelk still attached to their body, which, acting as a weight, caused them to sink the moment the swimming effort had ceased. Around, across, and in every direction the male fish, as the guardian, continually moved. Now his labours became more arduous and his vigilance was taxed to the utmost extreme, for the other fish (two Tench and a gold Carp), some twenty times larger than himself, so soon as they perceived the young fry in motion, continuously used their utmost endeavours to snap them up. The courage of the little Stickleback was now put to its severest test; but, nothing daunted, he drove them all off, seizing their fins and striking with all his strength at their heads and at their eyes. His care of the young brood when encumbered with the yelk was very extraordinary; and as this was gradually absorbed and they gained strength, their attempts to swim carried them to a greater distance from the parent fish; his vigilance, however, seemed everywhere, and if they rose by the action of their fins above a certain height from the shingle bottom, or flitted beyond a given distance from the nest, they were immediately seized in his mouth, brought back, and gently puffed or jetted into their place again*. The same care of the young, bringing them back to their nest up till about the sixth day after hatching, has been remarked by Dr. Ransom in the 10-spined Stickleback, *G. pungitius.*

The usual time for the Lamprey, *Petromyzon fluviatilis*, leaving the sea, which it is annually seen to do, in order to spawn, is about the beginning of spring; and after a stay of a few months it returns again to the ocean. Their preparation for spawning is very peculiar: their manner is to make holes in the gravelly bottoms of rivers; and on this occasion their sucking power is particularly noticeable, for if they meet with a stone of considerable size, they will remove it and throw it out. Their young are produced from eggs; the female remains near the place where they are excluded, and continues with them till they come forth.

* Warrington, "On the Habits of the Stickleback," Ann. & Mag. Nat. Hist 1855, xvi. p. 330.

She is often seen with her whole family playing about her, and after some time she conducts them in triumph to the ocean. (*Buffon.*)

Among the Lophobranchiate order of fish, or those in which the gills consist of small rounded tufts attached to the branchial arches, and which are represented by the Pipe- and Horse-fishes of the British seas, we find that in most of the species the males perform the function of hatching the eggs, which for that purpose are deposited up, to the time of the evolution of the young, either between the ventrals (in the genus *Solenostomus*), or in tail-pouches (in *Hippocampus*), or in pouches on the breast and belly (in *Doryrhamphus*), or in rows on the breast and belly (in *Nerophis*), and are thus carried about by the fish*. M. Risso notices the great attachment of the adult Pipe-fish to their young, and this pouch probably serves as a place of shelter to which the young ones retreat in case of danger. I have been assured by fishermen that if the young were shaken out of the pouch into the water over the side of the boat, they did not swim away, but when the parent fish was held in the water in a favourable position the young would again enter the pouch†.

M. Carbonnier has recorded how the male of the curiously grotesque Telescope-fish, a variety of *Carassius auratus*, Linn., acts as accoucheur to the female. Three males pursued one female which was heavy with spawn, and rolled her like a ball upon the ground for a distance of several metres, and continued this process without rest or relaxation for two days, until the exhausted female, who had been unable to recover her equilibrium for a moment, had at last evacuated all her ova ‡.

That adult fish are capable of feeling affection one for another would seem to be well established: thus Jesse relates how he once captured a female Pike (*Esox lucius*) during the breeding-season, and that nothing could drive away the male from the spot at which he had perceived his partner slowly disappear, and whom he had followed to the edge of the water.

Mr. Arderon§ gave an account of how he tamed a Dace, which would lie close to the glass watching its master; and subsequently

* Kaup, Catal. Lopho. Fish in Brit. Mus. 1856, p. i.

† Yarrell, Brit. Fishes, 2nd ed. ii. p. 436.

‡ Compt. Rend. Nov. 4th, 1872, p. 1127.

§ Phil. Trans. Royal Society, 1747.

how he kept two Ruffs (*Acerina cernua*) in an aquarium, where they became very much attached to one another. He gave one away, when the other became so miserable that it would not eat, and this continued for nearly three weeks. Fearing his remaining fish might die, he sent for its former companion, and on the two meeting they became quite happy again. Jesse gives a similar account of two gold Carp. Mr. Oliver has recorded how a Trout was placed in a well at Dumbarton Castle, and died in 1809, after having inhabited that locality twenty-eight years. It had become so tame that it would receive its food from the hands of the soldiers. Lacépède relates how some fish, which had been kept in the basin of the Tuileries for upwards of a century, would come when they were called by their names; while in many parts of Germany, Trout, Carp, and Tench were summoned to their food by the ringing of a bell. "At a passage-place near to the city of Kandy, the fish formerly have been nourished and fed by the king's order, to keep them there for his majesty's pleasure; whither, having been used to be thus provided for, notwithstanding floods and strong streams, they will still resort, and are so tame that I have seen them eat out of men's hands"*. Ellis, in his 'Polynesian Researches,' speaks of a native chief of the island of Hawaii who had brought eels to that degree of tameness that he could call them from their retreat with the shrill sound of a whistle. Pliny also remarks that eels may be tamed so completely that they will eat out of your hand. At Erritara Carvee, in the Cochin state of Malabar, is an umbalum situated on the bank of the deep river, which is 500 yards wide, where the fish receive a supply of food every week; here hundreds of Carp (*Barbus*) flock up to obtain rice from passers-by, and are so tame that they will take food from a person's hand†. At many temples in India fishes are called to receive food by means of ringing bells or by musical sounds. Lieutenant Conolly remarks upon seeing numerous fishes coming to the ghaut at Sidhnath to be fed when called; and on expressing our admiration of the size of the fish, "Wait," said a bystander, "until you have seen 'Raghu.'" "The Brahmin called out his name in a peculiar tone of voice, but he would not hear. I threw in handful after handful of ottah (flour) with the same success, and was just leaving the ghaut, despairing and doubting, when a loud plunge startled me. I thought somebody had jumped off the bastion of the

* Knox, Ceylon, 1681, p. 56.

† Day, 'Land of Permauls,' 1863, p. 502.

ghaut into the river, but was soon undeceived by the general shout of 'Raghu,' 'Raghu,' and by the fishes large and small darting away in every direction. Raghu made two or three plunges, but was so quick in his motions that I was unable to guess at his species"*. In Burma, in the Irrawaddi river, there are fish so tame as to come up to the sides of the boat, and even allow themselves to be handled. The Fakeers of the place call them together, but they are not much disposed to come for mere calling, seeming to require more substantial proof of being wanted in the shape of food; they are found in still waters in a small bay, which is closed up still more from the influence of the stream by a round island constructed superficially on a rocky base, and on which the pagodas are built. They resemble a good deal the *Gooroo mas*, a Siluroid of Assam, but have no large teeth as it has (most probably the fish was a *Rita*). They are very greedy, of a bluish-grey colour, occasionally inclining to red (Griffith, p. 104). Carew, in Cornwall, is said to have called his Grey Mullet together by making a noise like chopping with a cleaver; and Sir Joseph Banks collected his fish by means of sounding a bell.

The manifestations of anger are well described in the accounts we possess of the Fighting Fishes of Siam. After remarking on the cock-fights of that country, Sir J. Browning† adds, there is a little bellicose fish, too, which attacks its fellow with great ferocity, bristling its fins and exhibiting the most intense excitement; one of these, seeing its reflection in a glass, will violently advance head foremost against the shadow. Dr. Cantor‡ observes, respecting this fish, *Macropodus pugnax,* that when it is in a state of quiet, with the fins at rest, the dull colours present nothing remarkable. But if two are brought within sight of each other, or if one sees its own image in a looking-glass, the little creature becomes suddenly excited, the raised fins and the whole body shine with metallic colours of dazzling beauty, while the projected gill-membranes, waving like a black frill round the throat, add something grotesque to the general appearance. In this state it makes repeated darts at its real or reflected antagonist; but both, when taken out of each other's sight, instantly

* Conolly, "Obs. on past and present Condition of Onjein," J. As. Soc. Beng. vi. p. 820.

† 'Kingdom and People of Siam,' p. 155.

‡ 'Catal. Malay. Fish.' 1850, p. 87.

become quiet. When a few examples of the three-spined Stickleback (*Gasterosteus aculeatus*) are first turned into a tub of water, they swim about in a shoal, apparently exploring their new habitation. Suddenly one will take possession of a particular corner of the tub, or, as will sometimes happen, of the bottom, and will instantly commence an attack upon his companions; and if any one of them ventures to oppose his sway, a regular and most furious battle ensues; the two combatants swim round and round each other with the greatest rapidity, biting and endeavouring to pierce each other with their spines, which on these occasions are projected. I have witnessed a battle of this sort which lasted several minutes before either would give way; and when one does submit, imagination can hardly conceive the vindictive fury of the conqueror, who, in the most persevering and unrelenting way, chases his rival from one part of the tub to another, until fairly exhausted with fatigue. I have occasionally known three or four parts of the tub taken possession of by as many other little tyrants, who guard their territories with the strictest vigilance; and the slightest invasion invariably brings on a battle. These are the habits of the male fish alone*. After a fight between two examples a strange alteration takes place almost immediately in the defeated party: his gallant bearing forsakes him, his gay colours fade away, he becomes again speckled and ugly, and hides his disgrace among his peaceable companions, who occupy together that part of the tub which their tyrants have not taken possession of; he is, moreover, for some time the constant object of his conqueror's persecution†. We here perceive how the disgrace of defeat affects the spirits of the vanquished, and this reacting on the health, causes his brilliant hues to fade away. The conqueror, on the other hand, exulting in his victory, becomes more resplendent: he does not forget his former triumph, and considers it no disgrace to occasionally lord it over his fallen foe. Under the influence of fear, the Indian Climbing-Perch (*Anabas scandens*) not only erects its spiny-rayed fins, but also its scales, even down to those situated at the base of its caudal fin.

Every one who possesses an aquarium knows how, on a spiny-rayed fish being frightened or angry, he at once elevates his fins. The *Diodon* has several means of defence. It can give a severe

* Mag. Nat. Hist. iii. p. 330.

† Couch, 'British Fishes,' i. p. 172.

bite; while by inflating its body, the papillæ with which the skin is covered become erect and pointed*. Mr. Whitmee observes:—"I have seen a *Balistes* (File-fish) swim rapidly past its antagonist and graze its side with its file-like lateral spines." "I once tried to catch a *Tetrodon nigripunctatus* which was in my aquarium, when it inflated itself and elevated the fine spines with which the body was covered, and which were previously buried in its loose and flabby skin. This of course was under the influence of fear"†. Siluroids are furnished with more than one mode of attack. In the Ohio exists a species of this family, in which the first dorsal ray is formed of a very strong and short spine, which the animal uses to kill others of a smaller size; for this purpose it gets beneath the fish it intends to attack, and then suddenly rises and wounds it repeatedly in the belly. There is another curious form in Burma (*Macrones leucophasis*) said to swim with its belly uppermost, therefore termed by the Burmese the "Topsy-turvey fish;" it probably ascends to above its prey. Lately I have been favoured with the sight of a drawing of a fish, *Bagrus*, existing in the Nile which is observed, while in an aquarium, to swim in a similar manner. Siluroids likewise erect the osseous and armed spines of their dorsal and pectoral fins. Some years since, while stationed at Madras, I obtained several live examples of these fishes, *Macrones vittatus*, termed the Fiddler-fish in Mysore. I touched one which was lying on some wet grass; it became very irate, erecting its armed spines and emitting a sound resembling the buzzing of a bee, evidently a sign of anger or terror. Having placed some small Carp in an aquarium containing one of these fish, it rushed at a small example, seized it by the middle of its back, and shook it as a dog kills a rat: at this time its barbels were stiffened out laterally like a cat's whiskers. Couch observes of the Stickleback, or Pricklebacks, that "the bite of these little furies is so severe, that I have frequently known it, when inflicted on the tail, produce mortification and consequently death. They also use their lateral spines (ventral fins) with most fatal effect, that, incredible as it may appear, I have seen one during a battle absolutely rip his opponent quite open, so that he sank to the bottom and died."

Jesse mentions a gentleman walking by the side of the river Wey who observed a large Pike in shallow water. Pulling off

* Darwin, 'Voyage of Beagle,' iii. p. 13.

† Whitmee, Proc. Zool. Soc. 1878, p. 133.

his coat and tucking up his shirt-sleeves, he entered the water and tried to intercept the fish's return to the river, endeavouring to get his hands beneath it and throw it on to the bank. The Pike finding his escape likely to be cut off, assumed the offensive, seizing one of the gentleman's arms with his teeth and severely lacerating it: it had evidently argued that it must by force put the cause of its impediment to rout. Mr. J. Faraday, at the Manchester Anglers' Association, read a paper, in December 1878, recording an instance of apparent intelligence in a Skate which he observed while officiating as Curator of the Aquarium. A morsel of food thrown into the tank fell directly in an angle formed by the glass front and the bottom. The Skate, a large example, made several vain attempts to seize the food, owing to its mouth being on the underside of its head and the food being close to the glass. He lay quite still for a while as though thinking, then suddenly raised himself into a slanting posture, the head inclined upwards and the under surface of the body towards the food, when he waved his broad expanse of fins, thus creating an upward current or wave in the water, which lifted the food from its position and carried it straight to his mouth*.

Certain fishes likewise are endowed with specific means of showing their being affected by anger or terror, as the Electric Eel (*Gymnotus electricans*), which possesses electric organs of such power as to be capable of causing death even to large animals. Humboldt and others have recorded how the Indians in South America, when they desire to capture these fish, drive horses and mules into waters which they inhabit, when, as soon as disturbed, these eels attack the intruders. They first glide under the horses' bellies and prostrate them by repeated electric shocks, which, however, by degrees become of less and less intensity, as long rest and nourishment are required to repair the galvanic force which they have expended. It has been considered that the possession of this power is for the purpose of protecting the Electric Eel against Alligators; and it is certainly employed against other fish which it requires as food; but its onslaught on intruding horses must clearly be the effect of anger or terror. The power decreases, and is perhaps eventually lost, in examples which are kept in confinement. Even in British seas, we know, exists a fish endowed with this electric property, viz.

* Nature, Dec. 19, 1878.

the Electric Ray or Torpedo, commonly known as the Cramp-fish, *Torpedo hebetans* and *T. marmorata*. The instant it is touched it numbs not only the hand and arm, but its effects are said sometimes to extend to the whole of the body. This electric shock is thus described by Kempfer:—The nerves are so affected that the person struck imagines all the bones of his body, and particularly those of the limb that received the blow, are driven out of joint. It is accompanied with a universal terror, a sickness of the stomach, a general convulsion, and a total suspension of the mind. As examples of the Surmullet and Plaice have been found inside Torpedos, while it is manifestly impossible they could have captured such by outswimming them, it has been conjectured that they must have taken their prey by means of stupefying them with electric shocks. Whether we are to consider attacks made by Sword-fishes upon passing vessels as due to anger at being disturbed, or under the impression that they are attacking their enemies the Whales, is questionable; but it is a well-ascertained fact that the planks of numerous ships, especially in the Indian seas, have been pierced by the strong rostral apparatus with which these fishes are provided either for offence or defence.

Fear is frequently shown; as small birds mob those of prey, so little fish will mob others that they dread. Some small species were kept by Mr. Whitmee in an aquarium with an *Antennarius*, and were evidently in great dread of their carnivorous neighbour, which they continually tried to torment. In attacking it they always took care to strike at its posterior part, although this was protected by a rock of coral *.

Likewise fish, when hooked or netted, sometimes empty their stomachs by an instinctive act of fear, or to facilitate escape by lightening their load †. Hooker remarks respecting Gulls, Terns, Wild Geese, and Pelicans in the Ganges valley, that these birds congregate by the sides of pools and beat the water with violence so as to scare the fish, which then become an easy prey, a fact which was, I believe, indicated by Pallas during his residence on the banks of the Caspian Sea ‡. Along the muddy shores of tropical countries and up the sides of large

* Proc. Zool. Soc. 1878, p. 133.

† Owen, 'Comp. Anat.' p. 419.

‡ 'Himalayan Journal,' i. p. 80.

rivers are many forms of fish, especially belonging to the family of Gobies or Blennies, that wander over the mud or climb rocks left uncovered by the water, or on to the damp stems of trees left exposed by an ebbing tide; and here they crawl about searching for insects: but let them be alarmed, and what an instant commotion ensues; some dive down at once into the soft mud, others fly over the water to a place of safety like a piece of slate sent skimming by a school-boy. Many small fishes, as Blennies &c., when the tide ebbs, are left in small pools, where they conceal themselves under stones. The larger Blennies quit the water, and using their pectoral fins as organs of prehension and locomotion, creep into suitable holes, where, with their heads towards the sea, they await the flow of the tide, which they know will restore them again to their native element. Often does the observer in the tropics see fish jumping out of the water in terror from some unseen foe; and should a net be skilfully placed, the cause of this commotion may be taken. I have found the Garfish (*Belone*) is occasionally the form which the smaller herrings are flying from or else the Bonito. The Skipper (*Belone vulgaris*) of the British seas is observed at times to show great terror at being pursued by Porpoises, Tunies, and Bonitos. Multitudes, observes Couch, then mount to the surface and crowd on each other as they press forwards. When still more closely pursued, they singly spring to the height of several feet, leap over each other in singular confusion, and again sink beneath. The Flying-fish (*Exocœtus*) is likewise a form which springs out of the water to escape its rapacious pursuers. Friar Odoric, who visited Ceylon about A.D. 1320, observe that there are "fishes in those seas that come swimming towards the said country in such abundance, that for a great distance into the sea nothing can be seen but the backs of fishes, which, casting themselves on the shore, do suffer men for the space of three daies to come and to take as many of them away as they please; and then they return again to the ocean."*

Among the coral reefs of the Andaman Islands I found the little *Heliastes lepidurus* abundant. As soon as any thing splashed into the water, they appeared to retire for safety to the branching coral, a locality where no large fish could intrude; so frightened did they become, that on an Andamanese diving from the

* Hakluyt, ii. p. 37.

side of a boat, they at once took refuge in the coral, remaining in it even after it was removed from the sea. In Burmese rivers, where weirs are not permitted to entirely span rivers (as such would impede navigation), the open side as far as the bank is studded with reeds; these, as the water passes over them, vibrate, thus occasioning an unusual sound, alarming the fish and frightening them over to the weired side of the stream. Every angler knows the natural timidity of fish; and keepers are aware how easily poachers deter Salmon from ascending fish-passes.

At the Andaman Islands fish are captured by the convicts by means of weirs fixed across the openings of creeks. After existing a week or so, it is observed that captures invariably cease; and it is believed that such is due to barnacles &c. clustering on to the wood of which they are composed. It does not seem improbable that the fish have learned to avoid a locality out of terror at those which enter but do not again return.

Many fishes when captured emit sounds which appear to be due to terror, as a Scad or Horse-Mackerel (*Caranx hippos*), a Globe-fish (*Tetrodon*), and others grunt like a Pig. A Siluroid found in the Rio Parana, and called the Armado, is remarkable for a harsh grating noise which it emits when caught by hook and line: this can be distinctly heard while it is still beneath the water*. The Cuckoo-Gurnard (*Triga pini*) and the Maigre (*Sciæna aquila*) utter sounds, not only while being removed from the water, but the latter likewise, when swimming in shoals, emits grunting or purring noises that may be heard from a depth of 20 fathoms†. Herrings (*Clupea harengus*), when the net has been drawn over them, have been observed to do the same. The freshwater Bullhead (*Cottus gobio*) emits similar sounds.

Speaking of the river on which Brunei is situated in the kingdom of Borneo proper, St. John remarks:—"I have described in a previous chapter the appearance of the river; but I have not mentioned that here I have most often heard the Singing or Humming-fish, which sticks to the bottom of the boat, and produces a sound somewhat like that of a Jew's harp struck slowly, though sometimes it increases in loudness, so as to resemble the full sound or tones of an organ. My men have pointed me out a fish about 4 inches long as the author of the music. It is marked

* Darwin, 'Nat. Journal,' vol. vii.

† Yarrell, 'Brit. Fish.' 2nd edit. i. pp. 44, 106.

with alternate stripes of black and yellow across the back"*. Pallegroix observes that in Siam the Dog's-tongue is a fish shaped like a Sole: it attaches itself to the bottom of boats and makes a sonorous noise, which is more musical when several are stuck to the same boat and act in concert †. While on board the brig 'Ariel,' observes Adams, in the 'Journal of the Samarang,' "then lying off the mouth of the river of Borneo, I had the good fortune to hear that solemn aquatic concert of the far-famed Organ-fish or Drum-fish, a species of *Pogonias*. These singular fishes produce a loud monotonous singing sound, which rises and falls, and sometimes dies away, or assumes a very low drumming character, and the noise appeared to proceed mysteriously from the bottom of the vessel. This strange submarine chorus of fishes continued to amuse us for about a quarter of an hour, when the music, if so it may be called, suddenly ceased, probably on the dispersion of the band of performers." Sir Emerson Tennant observed that a Siluroid fish (*Clarias*) found in the lake at Colombo is said by the fishermen to make a grunt under water when disturbed. Ælian tells us that the Shad (*Clupea*) appears to take pleasure in the sounds of musical instruments; while should it thunder during the period they are ascending rivers, they rapidly return to the sea.

Companionship or friendship (as apart from affection) is shown in fishes, while we sometimes perceive such inspired by motives of gain. Mr. H. Shaw, of Shrewsbury, informs me that a gentleman near that town made the acquaintance of a Trout, over a pound weight, then residing in a brook at Borton Cliff, and was accustomed to constantly supply it with caterpillars which he obtained from the gooseberry- and other bushes and carried in a cabbage-leaf to the stream. He flicked them off into the water with a small stick, as one day he found that having taken a caterpillar up in his fingers and thrown it to the fish, it apparently seized it, but seemed at once to eject it, and with a whisk of his tail it immediately disappeared. The same result occurred after every repetition of the experiment, although it latterly returned more quickly than at first. The amount of caterpillars it consumed was enormous. Friendship here was doubtless due to this supply of food, while taste or smell must have induced fear,

* Life in the Forests of the Far East,' vol. ii. p. 276.

† Pallegroix, *l. c.* p. 93.

and caused its rapid flight. Many species are gregarious, moving about in large schools; others, again, merely in pairs.

During the breeding-season most, if not all, Teleostean fishes have more resplendent tints than at any other period of the year, and which may be for the purpose of mutual attraction. A good example is seen in the Salmon, while I have observed the same circumstance occur in the beautiful little Goby (*Periophthalmus Schlosseri*) which frequents the river Irrawaddi and its banks. Jordan and Copeland*, observing upon the John Darters (*Etheostoma blennoides*), remark upon a male in their aquarium which underwent, almost in an instant, an entire change of pattern (in the colours of his body) upon the introduction of a female fish of the same species. Even after two weeks the novelty had not worn off, though his body-colours varied much from hour to hour, but had not reverted to his original dress.

There is a curious instinct of some fishes to take up their residence inside other animals, or else to attach themselves to them in order to profit by the greater power of locomotion in their host, from whose body, however, they draw no sustenance, but merely partake of such food as comes within their reach. These latter, termed *Commensals*† by Van Beneden, may be either free or fixed to their host; and a common example of a *Commensal* is the Sucking-fish (*Echeneis*), which, having but weak fins, attaches itself to any large swimming or floating object, animate or inanimate, as ships, sharks, whales, &c., not for the purpose of feeding upon them, but to enable it to profit by their powers of locomotion, and so enable it to capture other small fishes, upon which it mostly subsists. Commerson assures us that, having applied his thumb to the adhesive organ of a living Sucking-fish, the adhesion was so strong that it became numbed, and an almost partial paralysis continued for some considerable time subsequently. During stormy weather it adheres like limpets to a rock. Another circumstance related by Commerson is, that in the Indian seas a ring is fastened round the tail of one of these fish so as to prevent its escape; to the ring is attached a long cord, and it is thus carried in a vessel of salt water; and when boatmen observe a turtle asleep on the surface of the water, they approach as close as they can, then throw the Sucking-fish into the sea: it attaches itself to the breast of the turtle, and is thus drawn into the boat. The

* American Journal, 1878, p. 338.

† Bulletin Ac. Belg. 1869, xxviii. p. 621.

Lump-sucker (*Cyclopterus*) is said to fix itself by its ventral sucker to the neck of the savage Wolf-fish (*Anarrhichas lupus*), and adheres thus immovably, tormenting it in such a manner as to cause its death *.

When investigating the fishes at the Andaman Islands in 1870, one of the aborigines brought an example of the pretty yellow-and-white banded *Amphiprion percula*; and on being told that it was good, observed that she could get numbers more. She took us to an *Actinia*, which she detached from the coral rock by inserting her hand behind the attachment of this polype; and on shaking it, two more of these little fish fell out. Subsequently this was repeated to twelve others, and all had two living fishes inside them except one, which had three. They asserted that this was their usual abode. A few days previously Captain Hamilton had observed to me that some little striped fishes lived inside a polype at North Bay. One day he dug one out, dragged it to the shore, and captured three little fish from its interior; replacing them in the sea, they appeared not to know what to do, swimming round and round as if searching for something. The living polype was now returned to the sea, and they at once swam to it, following it as it was dragged back again through the water to its original locality. As I was going over to North Bay fishing, he came with me to see if he could not find a specimen. Unfortunately, after discovering one and obtaining a fish from it (*Amphiprion bifasciatum*), he was stung by the polype, which I did not see †. Dr. Andrews ‡ has observed upon the *Holothuria*, or Trepang of the seas of China, that fish live inside it; in fact he saw instances of living fish entering the Trepang. On the Coromandel coast of India at Gopaulpore I found the small perciform *Therapons* residing inside *Medusæ*, and which the fishermen asserted to be of common occurrence. Gill observes §:—"In the eastern waters of the United States, however, so far as I am aware, the Stromatoid fish *Poronotus similis* (*Stromateus similis* of some authors) seems to be the most common, if not the only associate of several Acalephs, viz. *Dactylometra quinquecirra*, *Zygodactylon grœnlandica*, and *Cyarea arctica*. Under the umbrellas of these species small *Poronoti* are to be found in the late

* Shaw, Zool. iv. p. 96.

† Day, "Obs. on the Andamanese," Proc. As. Soc. Beng. 1870, p. 176.

‡ Meeting Brit. Assoc., Aug. 17th, 1878.

§ Nature, Aug. 30th, 1877, p. 362.

summers swimming, sometimes even to the number of twenty or more, but generally much fewer."

It can scarcely be denied that some fishes are endowed with a certain amount of intelligence: thus flat fishes, Pleuronectidæ, conceal themselves beneath the sand, as, owing to their shape, but little is required to cover them; consequently by setting up an undulating body movement, this is easily effected. Skates and Rays similarly conceal themselves in the sand. The Sand-Launce (*Ammodytes lanceolatus* and *A. tobianus*), commonly frequenting our coasts, lies imbedded in the sand, in which it conceals itself at the depth of about a foot, with its body rolled into a spiral form*. The Stargazer (*Uranoscopus scaber*) chiefly frequents shallows, where it remains hidden in the mud with merely its head exposed. In this situation it waves the beards of its lips, and especially the long cirrus of its mouth, in various directions, thus allowing the smaller fishes and marine insects which may happen to be swimming near, and which mistake these organs for worms, to become instantly seized by their concealed enemy. I obtained in March 1868 at Madras a living example of a fish belonging to this family (*Ichthyscopus inermis*), the Tamil name of which signified "a diver into the mud." It was placed in an aquarium which possessed a bed of mud, into which it rapidly worked itself, first depressing one side and then the other, until merely the top of its head and snout remained above the mud, while a constant current of water was kept up through its gills. While in the mud it resembled a frog; if lifted out of the aquarium, it ejected water from its mouth to some distance, making a curious noise, half croaking and half snapping†. An Indian freshwater Siluroid (*Chaca lophioides*) conceals itself among the mud, from which, by its lurid appearance and a number of loose filamentous substances on its skin, it is scarcely distinguishable; and with its immense open mouth it is ready to seize any small prey that is passing along‡. The Angler, or Fishing-Frog (*Lophius piscatorius*), crouching close to the ground, by the action of its ventral and pectoral fins stirs up the sand and mud; hidden by the obscurity thus produced, it elevates its appendages (situated on the upper surface of its head), moves them in various directions by way of attraction as a bait, and the small fishes approaching either to

* Shaw, Zool. iv. p. 81.

† Day, 'Fishes of India,' p. 261.

‡ Ham. Buch. 'Fish. Ganges.'

examine or seize them, immediately become the prey of the fishes (*Yarrell*). The Weaver (*Trachinus vipera*) buries itself in the sands, leaving only its nose out, and if trod on immediately strikes with great force; and we have seen them direct their blows with as much judgment as fighting-cocks *. The Conger-Eel (*Conger vulgaris*), remarks Couch, is able to insinuate the point of its tail through a crevice and so dilate it as to obtain a passage for its body by a retrograde action; or if that cannot be accomplished, it will examine by its powers of sensation, draw itself along, and, using the tail as a fixed point, elevate its body as a lever and lift itself over any opposing obstacle of considerable height; so that neither the Eel (*Anguilla*) nor the Conger can be confined within a limited space when their inclinations prompt them to wander from it.

The Jaculator-fish (*Chelmon rostratus*) frequents shores and sides of rivers near the sea in Asia in search of food. When it sees a fly sitting on the plants that grow in shallow water, it swims to the distance of 4, 5, or 6 feet, and then, with surprising dexterity, it ejects out of its long and tubular mouth a single drop of water, which never fails striking the fly into the sea, when it becomes its prey. This aroused Governor Hommel's curiosity, and he had a large tub filled with sea-water, in which he placed some of these fish. When they were reconciled to their situation, a slender stick with a fly pinned on its end was placed in such a direction on the side of the vessel that the fish could strike it. It was with inexpressible delight that he daily saw these fish exercising their skill in shooting at a fly; and they never missed their mark. Pallas continued this account from Governor Hommel's letters two years subsequently, remarking that when the Jaculator-fish intends to catch a fly or any other insect which is seen at a distance, it approaches very slowly and cautiously, and comes as much as possible perpendicularly under the object; then the body being put in an oblique situation, and the mouth and eyes being near the surface of the water, the Jaculator stays a moment quite immovable, having its eyes fixed directly on the insect, and then begins to shoot without ever showing its mouth above the surface of the water, out of which the single drop shot at the object seems to rise. With the closest attention, Governor Hommel never could see any part of the mouth out of the water, though

* Pennant's 'Brit. Zool.' iii. p. 170.

he has very often seen the Jaculator-fish shoot a great many drops one after another without leaving its place and fixed situation *.

The Common Eel, it is affirmed, voluntarily leaves the water at certain periods and wanders about meadows and moist grounds in quest of particular food, as snails &c.; it is also said to be fond of new-sown peas, which it has been observed to root out of the ground and devour during the night. If we may credit Albertus Magnus, it has been known during very severe frosts to take refuge in adjoining hay-ricks †.

Captain Arn, in a voyage to Hemel in the Baltic, gives the following interesting narrative:—"One morning during a calm, when near the Hebrides, all hands were called up at 2 A.M. to witness a battle between several of the fish called Threshers or Fox-Sharks (*Alopecias vulpes*) and some Sword-fish on one side, and an enormous Whale on the other. It was in the middle of the summer; and the weather being clear and the fish close to the vessel, we had a fine opportunity of witnessing the contest. As soon as the Whale's back appeared above the water, the Threshers springing several yards into the air, descended with great violence upon the object of their rancour, and inflicted upon him the most severe slaps with their long tails, the sounds of which resembled the reports of muskets fired at a distance. The Sword-fish in their turn attacked the distressed Whale, stabbing from below: and thus beset on all sides and wounded, when the poor creature appeared, the water around him was dyed with blood. In this manner they continued tormenting and wounding him for many hours, until we lost sight of him; and I have no doubt they in the end completed his destruction."

The master of a fishing-boat ‡ has recently observed that the Thresher-Shark serves out the Whales, the sea sometimes being all blood. One Whale, attacked by these fish, once took refuge under his vessel, where it lay an hour and a half without moving a fin. He also remarked having seen the Threshers jump out of the water as high as the mast-head and down upon the Whale, while the Sword-fish was wounding him from beneath, the two sorts of fish evidently acting in concert.

The Thresher or Fox-tailed Shark attacks its enemies or defends

* "On the Jaculator-Fish by Schlosser," Phil. Trans. Roy. Soc. Lond. 1764, vol. liv.

† Shaw, Zool. iv. p. 17.

‡ 'Land and Water,' 1879.

itself by blows from its elongated tail; and Couch remarks that it is not uncommon for one to approach a herd of Dolphins (*Delphinus*) that may be sporting in unsuspicious security, and by one splash of its tail on the water put them all to flight like so many hares before a hound.

The Pilot-fish (*Naucrates ductor*) appears to be a very companiable disposition, even though we omit the older legends that recorded how they pointed out the course of doubtful navigators, accompanying their ships throughout their voyages, and leaving them only when they had arrived at their desired haven. It is well known that they attach themselves to certain vessels for weeks and even months together, perhaps to obtain the food daily thrown overboard: but why they should accompany Sharks is a doubtful question. Some assert that this large and predacious fish is conducted to its prey by these fishes; others that they eat what the Shark leaves: however this may be, that they are often in company is an evident fact. Captain Richards, R.N., during his last station in the Mediterranean, saw on a fine day a Blue Shark, which followed the ship, attracted perhaps by a corpse which had been committed to the waves. After some time a shark-hook baited with pork was flung out. The Shark, attended by four Pilot-fish, repeatedly approached the bait; and every time that he did so, one of the Pilot-fishes preceding him was distinctly seen from the taffrail of the ship to run his nose against the side of the Shark's head to turn it away. After some further delay, the fish swam off in the wake of the vessel, his dorsal fin being long distinctly visible above the water. When he had gone, however, a considerable distance, he suddenly turned round, darted after the vessel, and before the Pilot-fish could overtake him and interfere, snapped at the bait, and was taken. In hoisting him up, one of the Pilots was observed to cling to his side until he was fairly above water, when it fell off. All the Pilot-fishes then swam about awhile, as if in search of their friend, with every apparent mark of anxiety and distress, and afterwards darted suddenly down into the depths of the sea*. Col. Smith states that he witnessed a precisely similar circumstance. M. Geoffrey, on the other hand, mentions how a Pilot-fish took great pains to bring a Shark to a bait.

Two Pilot-fishes accompanied a ship in 1831 from Alexandria to Plymouth. After she came to an anchor in Catwater, their

* Griffith, Cuv. An. King. x. p. 636.

attachment appeared to have increased; they kept constant guard at the vessel, and made themselves so familiar, that one of them was actually captured by a gentleman in a boat alongside, but by a strong effort it escaped from his grasp and regained the water. After this the two fish separated; but they were both taken the same evening, and, when dressed next day, were found to be excellent eating *.

Contempt does not seem to be unknown in this class of animals, and which appears to be sometimes shown by a stroke of the tail. Anglers frequently observe a fish swim up to their bait, not only refuse it, but give it a lash with their tail, and decline to have any thing more to do with it. This may, however, be a symptom of curiosity, which is largely developed in the finny tribes.

The poet Cowper crossing a brook, "saw from the foot-bridge something at the bottom of the water which had the appearance of a flower." "Observing it attentively," he continues, "I found that it consisted of a circular assemblage of Minnows: their heads all met in a centre, and their tails diverging at equal distances, and being elevated above their heads, gave them the appearance of a flower half-blown. One was longer than the rest; and often as a straggler came in sight, he quitted his place to pursue him; and having driven him away, he returned to it again, no other Minnow offering to take it in his absence. This I saw him do several times. The object that attracted them all was a dead Minnow which they seemed to be devouring" †.

I would submit that the foregoing facts respecting fish, collected from the writings of naturalists made in various parts of the globe, or else the result of personal observation, must lead us to doubt the very low estimate of the instincts and emotional sensations of the piscine tribes which has been attributed to them by some authors. At the same time we can hardly anticipate that these, the lowest forms of vertebrate life, have their faculties so acutely developed as they are in the higher races. Still it appears we are justified in claiming for some at least of this class of animals that they have attachments, whether in the form of conjugal feelings, paternal and maternal affections, or even of platonic friendship. Some construct nests, which they defend, as well as the young when hatched out. The males may act the part

* Yarrell, 'Brit. Fish.' 2nd. edit. vol. i. p. 172.

† Mag. Nat. Hist. v. p. 290.

of nurses to the eggs, either carrying them about in purses on even in their mouths. Lastly, I would allude to the fact that members of two distinct families may combine together for the purpose of attacking another inhabitant of the deep, and thus obtain a supply of food.

On the Extinct Land-Tortoises of Mauritius and Rodriguez. By ALFRED C. HADDON, B.A., Scholar of Christ's College, and Curator in the Museum of Zoology and Comparative Anatomy of the University of Cambridge. (Communicated by Prof. A. NEWTON, F.R.S.)

[Abstract, read November 20, 1879.]

THROUGH the generosity of Mr. Edward Newton, C.M.G., F.L.S., Lieutenant-Governor of Jamaica (late of Mauritius), a fresh collection of the remains of the Mascarene extinct gigantic land-tortoises has been added to his former gift to the Zoological Museum of the University of Cambridge.

An examination of these bones corroborates the two Mauritian species, *Testudo triserrata* and *T. inepta*, described by Dr. Günther*, but adds no fresh example to that apparently unsatisfactory species, *T. leptocnemis*. Although possessing a large series of remains from the island of Rodriguez, I am unable, like Dr. Günther, to distinguish more than the one species, *T. vosmæri*.

As examples of the inherent tendency to variation in these animals, I may draw attention to the ankylosis of the coracoid with the rest of the shoulder-girdle in one example of *T. inepta*, a circumstance which is unique ; also to the variations in the coracoid of *T. triserrata* as to form, markings, &c. The *free* coracoid of *T. inepta* is also described for the first time.

From the large number of specimens examined, it is now found that the coracoid of *T. vosmæri* was very irregular as to the time of its ankylosis with the rest of the shoulder-girdle, and that it was not the "apparently individual aberration" which Dr. Günther supposed.

Measurements are given of all the most interesting bones, in a manner similar to that adopted by Dr. Günther in his monograph, to facilitate comparison.

* 'The Gigantic Land-Tortoises (living and extinct) in the Collection of the British Museum.' By Albert C. L. G. Günther, M.A., M.D., Ph.D., F.R.S. London, 1877.

In conclusion, I would draw the attention of herpetologists to these collections of Mascarene Tortoise remains now in the Zoological Museum at Cambridge, since they form the most complete series of specimens of these very interesting extinct reptiles.

On a small Collection of Crustacea made by EDWARD WHYMPER, Esq., chiefly in the N. Greenland Seas; with an Appendix on additional Species collected by the late British Arctic Expedition. By EDWARD J. MIERS, F.L.S. &c.

[Read November 20, 1879.]

THE North-European and Greenland seas have been so thoroughly explored by British and Scandinavian naturalists, that it was not to be anticipated that the collection of Crustacea made by Mr. Whymper would contain much of novelty or great rarity, more especially as he appears to have had but few opportunities of collecting, several, indeed, of the species having been obtained by purchase from Danish sailors and others. A considerable proportion of the species were, however, collected by Mr. Whymper at a single locality—Hare Island, north of Disco Island, in about 30 fathoms of water, concerning which I transcribe the following note:—

"I got three hauls of a dredge as the ship was drifting, and got an immense assemblage of beasts and fishes. These were the richest hauls I have ever made with a dredge. I had to throw away the greater part of the hauls, from the impossibility of preserving the specimens. Thousands of Echinoderms and Mollusks came up."

It is very much to be regretted that the means of preserving the whole of the material dredged on this occasion did not exist; for, as it is, out of a total of twenty-seven species recorded below, no fewer than twelve were obtained at this locality, although unfortunately several of these are represented by but one or two examples in imperfect condition. The remainder of the collection chiefly consists of parasitic Isopoda and Copepoda and a few marine Copepoda obtained by washing from seaweed. The oceanic Copepoda are not included in the present Report, but have been submitted to Mr. Brady for examination.

The occurrence in fine condition of adult specimens of both sexes of the *Branchinecta arctica* of Verrill, affords me the opportunity of correcting an error in the figure of that species in my Report on the Crustacea collected by the naturalists of the late Arctic Expedition; and in an Appendix to the present paper I have added descriptions of two additional species collected in that expedition and not included in the Report.

The geographical range of species is given, except where I had previously noted it in my Report on the Arctic Crustacea; and some additional localities are cited from Prof. Smith's recently published "Report on the Crustaceans of the Atlantic Coast of N. America."

Decapoda.

Hyas coarctatus.

Hyas coarctatus, *Leach, Linn. Trans.* xi. p. 329 (1815); *Mal. Pod. Brit.* pl. xxi. β, fig. 1 ♂, 2 ♀; *M.-Edw. Hist. Nat. Crust.* i. p. 312 (1834); *Bell, Brit. Crust.* p. 35 (1853); *Goës, Œfv. Vet.-Ak. Förhandl.* p. 161 (1863).

Lissa fissirostra, *Say, Journ. Ac. Nat. Sci. Phil.* i. p. 79 (1817); *Gibbes, Proc. Amer. Assoc.* p. 171 (1850).

Several specimens are in the collection from North Greenland; no definite particulars are recorded with respect to their habitat. This is a very widely distributed species, as it is known to occur on both the eastern and western coasts of the N. Atlantic, and its circumpolar distribution extends eastward to the Sea of Okhotsk, where a variety of this species has been found which has been designated "*alutacea*" by Brandt.

Crangon (Cheraphilus) boreas.

Cancer boreas, *Phipps, Voy. North Pole,* p. 190, pl. xii. fig. 1 (1772).

Cancer homaroïdes, *O. Fabr. Fauna Grœnland.* p. 241 (1780); *Mohr, Isl. Naturh.* p. 108. no. 245, pl. v. (1786).

Crangon boreas, *Fabr. Ent. Syst. Suppl.* p. 410 (1798); *M.-Edw. Hist. Nat. Crust.* ii. p. 342 (1837); *Kröyer, Nat. Tidsskr.* iv. p. 218, pl. iv. figs. 1–14 (1842–43).

Cheraphilus boreas, *Kinahan, Proc. Royal Irish Acad.* viii. p. 68 (1864); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4), xx. p. 57 (1877).

Hare Island, north of Disco Island (in about 30 fathoms), two males and four females. From Umenak, several specimens (some purchased of a Danish sailor, and said to have been taken from the "stomach of the frog-fish"). It is widely distributed

through the circumpolar seas; and S. I. Smith records it from several localities on the North-Atlantic American coast.

Mr. Kingsley, who is engaged upon a monograph of the North-American Caridea, and who has recently published, in the 'Bulletin of the Essex Institute,' vol. x., a most useful critical list of all the North-American species, is of opinion that the genus *Cheraphilus* as defined by Kinahan cannot be maintained, as "it has not a single character common to all the species to separate it from *Crangon*, as restricted by him." Even if this be the case, it does not follow that the name, having been published, should not be used with a slightly modified definition of the genus, more especially as the genus *Crangon*, even in the sense accepted by Sars, includes species so diverse in the sculpture of the carapace and postabdominal segments. In my Report on the Arctic Crustacea I adopted Kinahan's term *Cheraphilus*, as I considered it would be useful to retain it as a separate designation for those species of *Crangon* which, like *C. boreas* and *C. salebrosus*, Owen, are of very large size, with median and lateral series of spines on the cephalothorax, and with all the segments of the postabdomen longitudinally keeled above, in contradistinction to the smaller less robust species (e. g. *C. vulgaris*, *franciscorum*), in which the cephalothorax and postabdominal segments are nearly smooth. Nevertheless, not being acquainted with all the species, I retain the name here merely as a sectional division of *Crangon* in the sense indicated above; intermediate forms undoubtedly occur, and there is no modification in the structure of the limbs of the cephalothorax, such as exists, for instance, in the allied genus *Sabinea*, Owen.

HIPPOLYTE SPINUS.

Cancer spinus, *Sowerby, Brit. Miscel.* p. 47, pl. xxiii. (1806).
Hippolyte Sowerbei, *Kröyer, Monogr. Hippolyte's nord. Arter*, p. 90, pl. ii. figs. 45–54 (1842).
Hippolyte Sowerbyi, *M.-Edw. Hist. Nat. Crust.* ii. p. 380 (1837).
Hippolyte spinus, *Bell, Brit. Crust.* p. 284 (1855); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4), xx. p. 59 (1877).

Two small specimens were dredged off Hare Island in the same rich haul in which so many of the species here noticed were obtained. One is a female with ova. In this specimen the two last teeth of the median dorsal crest are simple. In the other specimen the teeth of the dorsal carina are themselves denticu-

lated, and the minute denticules interposed between the teeth on the upper margin of the rostrum are far more numerous; there are four small teeth at the distal extremity of the rostrum, and one or two on the inferior margin. Compared with the much larger specimens obtained during the British Arctic Expedition, the denticulations are more numerous and the dorsal carina not so prominent; yet I do not doubt that the species are identical. On account of the variability of the rostral teeth, I am inclined to doubt the distinctness of *H. securifrons*, Norman (*H. Liljeborgi*, Danielssen and Boeck), from *H. spinus*. Many species, it has been observed, increase in size as they advance into the colder regions of the extreme north; and at the same time considerable variation may often be noted in the sculpture and armature of the body. In addition to the localities mentioned in my Report on the Crustacea of the Arctic Expedition, I may note that Stimpson and Smith record this species as common on the coasts of Maine and Massachusetts, and also in the Grand Manan.

HIPPOLYTE POLARIS.

Alpheus polaris, *Sabine, Append. Parry's 1st Voy.* x. p. 60, pl. ii. figs. 5–8 (1821).

Hippolyte polaris, *Ross & Owen, Append. Ross's 2nd Voy., Zool., Crust.* p. lxxxv (1835); *M.-Edw. Hist. Nat. Crust.* ii. p. 376 (1837); *Kröyer, Monogr. Hipp. nord. Art.* p. 116, pl. iii. figs. 78–81, pl. iv. (1842); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4), xx. p. 61 (1877).

Hippolyte borealis, *Owen, Append. Ross's 2nd Voy., Cr.* p. lxxxiv, pl. B. fig. 3 (1835); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4), xx. p. 61 (1877), ♂.

Several specimens were dredged off Hare Island. The only two perfect specimens have the rostra $\frac{5-6}{2}$-toothed, and thus agree more nearly with Kröyer's diagnosis than do the specimens collected in the Polar Sea by the late British Arctic Expedition.

Prof. S. I. Smith, in his "Report on the Crustaceans of the Atlantic Coast," records the occurrence of this species on the coast of Labrador, Nova Scotia, and Massachusetts.

HIPPOLYTE GRŒNLANDICA.

Astacus grœnlandicus, *J. C. Fabr. Syst. Ent.* p. 416 (1775).

Cancer aculeatus, *O. Fabr. Fauna Grœnlandica*, p. 289 (1780).

Hippolyte aculeata, *Owen & Ross, Crust. in Append. Ross's 2nd Voy.* p. lxxxiii (1835); *M.-Edw. Hist. Nat. Crust.* ii. p. 380 (1837);

Kröyer, Monogr. Hippolyte's nord. Arter, p. 126, pl. iv. figs. 83–98, pl. v. figs. 99–104 (1842).

Hippolyte grœnlandica, *Miers, Ann. & Mag. Nat. Hist.* ser. 4, xx. p. 62 (1877), ubi synon.

Two specimens (male and female) were collected at Hare Island; and another male was purchased at Umenak of a trader. It occurs, according to Prof. Smith, on the Atlantic coast of Northern America. As in the case of the specimens collected by the late British Arctic Expedition, the male now before me is much smaller than the female.

PANDALUS BOREALIS.

Pandalus borealis, *Kröyer, Nat. Tidsskr.* 2 R. i. p. 469 (1844–45); *Voy. en Scand. Atlas, Crust.* pl. vi. fig. 2; *Goës, Œfv. Vet.-Akad. Förhandl.* p. 168 (1863).

One female individual is in the collection, purchased of a trader at Umenak, with *Cheraphilus boreas*. It is unfortunately mutilated, the rostrum being broken off at a short distance beyond the eyes; but there can be no doubt of its identity with Kröyer's species, with the description of which it agrees in all essential characters. This species is found eastward as far as the Sea of Okhotsk, where its occurrence is recorded by Brandt; and its occurrence in Massachusetts Bay and on the coast of Maine and Nova Scotia is recorded by Smith.

SCHIZOPODA.

MYSIS OCULATA.

Cancer oculatus, *Fabr. Fauna Grœnland.* p. 245. no. 222 (1780).

Mysis Fabricii, *Leach, Trans. Linn. Soc.* xi. p. 350 (1815).

Mysis oculata, *Kröyer, Nat. Tidsskr.* ii. p. 255 (1838–39), 3 R. i. pp. 13, 41 (1861); *Voy. en Scand. Atlas, Crust.* pl. viii. fig. 2; *Buchholz, Zweite deutsche Nordpolarf.* p. 284 (1874); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4) xx. p. 63 (1877).

A single specimen was purchased of a Danish sailor at Umenak. It agrees with Kröyer's description and figure in all particulars, except that the lateral spinules on each margin of the telson are somewhat less numerous, about twenty-five instead of thirty-two; but this is probably a character varying with the age of the individual. Its length (excluding appendages) is about 8 lines.

Cumacea.

Diastylis Rathkii.

Cuma Rathkii, *Kröyer, Nat. Tidsskr.* iii. p. 513, pls. v. & vi. figs. 17–30 (1840–41), (N.R.) ii. pp. 144, 207, pl. i. figs. 4 & 6 (1846–49); *Voy. en Scand. Atlas, Crust.* pl. v. figs. 1 *a–u*.

Diastylis Rathkii, *G. O. Sars, Aberrante Krebsdyr. Cumacea, in Christ. Vidensk.-Selsk. Forhandl.* p. 160 (1864); *Svensk. Vetensk.-Akad. Handl.* ii. (No. 6) p. 7, pl. iii. figs. 8, 9 (1873).

A single individual was included among the species dredged off Hare Island in about 30 fathoms. Its length is about 6½ lines. It is found on the Atlantic coast of Northern America and in the seas of South Greenland, Scandinavia, and Britain, but more abundantly in the higher latitudes, and is perhaps the most common of the northern species of this curious group.

Isopoda.

Idotea, sp. yg ?

There is in the collection a specimen, apparently referable to this genus, which, on account of its very small size and imperfect condition, cannot be made the type of a detailed specific description, yet seems to be quite distinct from all the species known to me. The head is comparatively large, the frontal margin with a very slightly prominent broad median lobe. The eyes (black) are placed in the middle of the lateral margins of the head. The sides of the body are parallel, the segments of equal width, the three last segments having the postero-lateral angles subacute. There are four perfectly distinct postabdominal segments, the first three very short; the terminal segment is triangulate in form, with the angles rounded, broadest at base, where it exceeds in breadth the preceding segments, and with the sides convergent to the distal extremity, which is broad and obtusely rounded. The antennules are apparently four-jointed; the antennæ have six joints exposed, the four first thickened, and the two terminal slenderer and more elongated; the terminal ends in a pencil of fine hairs. The legs are imperfect, but are armed with subterminal as well as a terminal claw. The operculiform caudal appendages are not oblong, but rather oval in shape, narrowing to the distal extremity. Length 1½ line.

The only example collected was obtained by washing seaweed taken on the surface of the North mid-Atlantic in lat. 57° 59′ N.,

long. 19° 1′ W., with a few specimens of larval Cirripedia. On account of its very small size, I doubt if this specimen can be regarded as adult; but should the characters given prove constant, it may be designated after its discoverer, *I. Whymperi.*

In the parallel sides of the body and the existence of three perfectly distinct tail-segments besides the terminal segment, it has much affinity with the *Idotea parallela*, S. Bate & Westwood, 'Brit. Sessile-eyed Crust.' ii. p. 391 (1868); but in that species (not to speak of other differences) the terminal segment has the sides parallel, and is semicircularly rounded at its distal extremity.

The *Idotea rugulosa* of Buchholz, 'Zweite deutsche Nordpolarf. Crust.' p. 285, 1874, *note*, from Spitzbergen, is also a species with subparallel sides, but has the terminal segment emarginate at its distal extremity.

Idotea bicuspida, Owen, 'Cr. in Zool. of Capt. Beechey's Voyage,' p. 92, pl. xxvii. fig. 6 (1839), is at once distinguished by its more oval form and the emarginate tip of the terminal tail-segment.

ÆGA CRENULATA.

Æga crenulata, *Lütken, Naturhist. Foren. Vidensk. Meddelelser*, p. 70, pl. i. figs. 4, 5 (1858).

A specimen of this fine species is in the collection, which was purchased from a sailor at Umenak, who stated it to have been parasitic on a Greenland Shark. A specimen also from Greenland, in the British-Museum collection, presented some years ago by Mr. Whymper, is said to have been parasitic either on the Shark or the Cod.

Its length is no less than 2 inches 5½ lines (60 millims.).

ÆGA PSORA, *Linn.*

Oniscus psora, *Linn. Syst. Nat.* (ed. xii.) i. p. 1060 (1766); *Pennant, Brit. Zool.* iv. pl. xviii. fig. 1 (1777).

Æga emarginata, *Leach, Linn. Trans.* xi. p. 370 (1815); *M.-Edw. Hist. Nat. Crust.* iii. p. 240 (1840); *Crust. in Cuv. R. A.* (ed. 3), pl. lxxvii. fig. 1.

Æga psora, *Kröyer, Danmarks Fiske*, 2nd deel, p. 40 (1843–45); *Lütken, Naturhist. Foren. Vidensk. Meddelelser*, p. 65 (1858); *S. Bate & Westwood, Brit. Sessile-eyed Crust.* p. 238 (1862).

Four specimens are in the collection, obtained with *Æ. crenulata*. The largest measures about 1 inch 7½ lines. It is found in the British, Scandinavian, Icelandic, and Greenland seas; and

there is, according to Messrs. S. Bate and Westwood, a specimen from Nova Scotia in the Hopean Collection at Oxford.

Amphipoda.

Hyperia medusarum.

Cancer medusarum, *Müller, Zool. Dan. Prodromus*, p. 148 (1776).

Cancer (Gammarus) galba, *Montagu, Linn. Trans.* xi. p. 4, pl. ii. fig. 2 (1815).

Hyperia Latreillei, *M.-Edw. Hist. Nat. Crust.* iii. p. 76, pl. xxx. fig. 16 (1840).

Hyperia galba, *S. Bate, Cat. Amphip. Brit. Mus.* p. 292, pl. xlviii. fig. 9 (1862); *S. Bate & Westwood, Brit. Sessile-eyed Crust.* ii. p. 12 (1868).

Hyperia medusarum, *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 295, pl. xlix. fig. 1 (1862); *Boeck, Skandin. og Arktiske Amphip.* p. 79, pl. i. fig. 1 (1872), ubi synon.

A single adult female individual was obtained from a Danish trader at Niakornet.

The synonyma of this species, which appears to be as variable as it is common, is given at such length by Boeck (*l. c.*), that it appears unnecessary to reproduce it in full; and I must refer to his work for further information on the subject. It is commonly distributed throughout the N. Atlantic, British, Scandinavian, and Greenland seas.

Anonyx nugax.

Cancer nugax, *Phipps, Voy. North Pole, Append.* p. 192, pl. xii. fig. 2 (1774).

Anonyx lagena, *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 77, pl. xii. fig. 7, ♀ (1862); *Boeck, Skand. og Arktiske Amphip.* p. 152 (1872).

Anonyx nugax, *Miers, Ann. & Mag. Nat. Hist.* (ser. 4) xx. p. 96 (1877), ubi synon.

This common species is represented in the collection by three individuals collected, with so many other species, with the dredge off Hare Island.

Onesimus Edwardsii.

Anonyx Edwardsii, *Kröyer, Nat. Tidsskr.* 2 R. ii. pp. 1, 41 (1846); *Voy. en Scand., Crust. Atlas*, pl. xvi. fig. 1.

Onesimus Edwardsii, *Boeck, Skand. og Arktiske Amphip.* ii. p. 167, pl. vi. fig. 4 (1876); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4) xx. p. 99, pl. iii. fig. 3 (1877).

I refer here, with some hesitation, a number of small specimens obtained by the dredge off Hare Island. The colour of the eyes is indistinguishable in all the specimens. The terminal segment appears to vary somewhat as to the degree of its distal emargination. These specimens agree, however, in all respects with those described by me in the Report on the late Arctic Expedition.

LAPHYSTIUS STURIONIS.

Laphystius sturionis, *Kröyer, Nat. Tidsskr.* iv. p. 157 (1842); *Lillje-borg, Œfv. Vet.-Akad. Förhandl.* p. 132 (1855); *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 110 (1862).

Laphystius sturionis, *Boeck, Skandin. og Arktiske Amphip.* ii. p. 252, pl. xix. fig. 6 (1876); *Schiödte, Nat. Tidssk.* 3 R. x. p. 237, pl. v. figs. 9–18 (1876).

Darwinia compressa, *S. Bate, Brit. Assoc. Rep.* p. 58 (1855); *Cat. Amphip. Crust. Brit. Mus.* p. 108, pl. xvii. fig. 7 (1862); *S. Bate & Westwood, Brit. Sessile-eyed Crust.* i. p. 184 (1863).

This species was parasitic on a species of Cod caught by line in 100 fathoms in the North Sea in lat. 58° 53′ N., long. 1° 2′ E. Unlike the *Caligus curtus*, parasitic on the same animal (which was distributed over the body of the fish), this species was found only behind the pectoral fins at their bases; and was, as Mr. Whymper notes, sluggish in its movements compared with the other. Only a few specimens were preserved, the adults being females. It has been recorded, as Boeck notes, in the seas of Norway, Denmark, and Britain; but its range does not, as far as I am aware, extend northward to the coast of Greenland.

ŒDICERUS LYNCEUS.

Œdicerus lynceus, *M. Sars, Forhandl. Vidensk.-Selsk. Christiania*, p. 143 (1858); *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 372 (1862); *Boeck, Skand. og Arktiske Amphip.* ii. p. 259, pl. xiii. fig. 4 (1876).

Œdicerus arcticus, *Danielssen, Nyt Mag. f. Naturvidensk.* p. 7 (1857).

Œdicerus propinquus, *Goës, Œfv. Vet.-Ak. Förhandl.* p. 526, fig. 19 (1865).

Two specimens are in the collection (one in much mutilated condition), obtained in the dredge-haul off Hare Island in 30 fathoms.

They agree with the descriptions of the species in the form of the body and limbs, the absence of the spur-like prolongation of the wrist of the first pair of legs, and all other characteristics.

The rostrum, which is obtusely rounded at its apex, has at the apex on the lower margin an almost imperceptible point. It is found in the seas of Spitzbergen, Greenland, Iceland, and Norway.

Atylus carinatus.

Gammarus carinatus, *Fabr. Ent. Syst.* ii. p. 515 (1793).

Atylus carinatus, *Leach, Zool. Miscell.* iii. p. 22, pl. lxix. (1815); *M.-Edw. Hist. Nat. Crust.* iii. p. 68 (1840); *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 134, pl. xxv. figs. 1–3 (1862); *Buchholz, Crust. in Zweite deutsche Nordpolarf.* p. 357, pl. x. (1874); *Boeck, Skandinaviske og Arktiske Amphipoder,* ii. p. 324 (1876); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4) xx. p. 100 (1877).

Amphitho carinata, *Kröyer, Kongl. Danske Vid. Selsk.* Afh. vii. p. 256, pl. ii. fig. 6 (1838); *Voy. en Scand., Atlas, Crust.* pl. xi. fig. 1; *M.-Edw. Hist. Nat. Crust.* iii. p. 41 (1840).

A good series of specimens was dredged from a boat at Noursak at about 20 fathoms.

It is to be noted that these specimens are all of moderate or even small size, very much smaller than the specimens obtained by the British Arctic Expedition.

Gammarus locusta.

Cancer locusta, *Linn. Syst. Nat.* (ed. xii.) p. 1055 (1766).

Gammarus locusta, *Fabr. Ent. Syst.* ii. p. 516 (1793); *M.-Edw. Hist. Nat. Crust.* iii. p. 44 (1840); *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 206, pl. xxxvi. fig. 6 (1862); *Boeck, Scand. og Arktiske Amphip.* ii. p. 366 (1876); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4) xx. p. 101 (1877), ubi synon.

An adult female is in the collection, taken in the rich haul off Hare Island.

Several specimens were also washed out of seaweed floating on the surface of the sea at the entrance to Davis Straits, lat. 63° 27′ N., long. 54° 12′ W., with specimens of a species of Copepod (*Thalestris serrulata*, Brady).

Mr. Whymper notes that the species in this tube "lived in fresh water, and were as lively in it as in salt water."

The specimens taken from the seaweed are probably none of them fully adult, and some are quite young. In these, the eyes are oval, not uniform in shape; the fasciculi of hairs (in the larger specimens) on the dorsal surface of the fourth to the sixth postabdominal segments are long and slender, there are two hairs in the middle and two or three in each lateral fasciculus; the

accessory flagellum of the antennules is about 5-jointed, and terminates in a slender filament.

AMPELISCA ESCHRICHTII.

Ampelisca Eschrichtii, *Kröyer, Nat. Tidssk.* 1 R. iv. p. 155 (1842) *Boeck, Skand. og Arktiske Amphipoder,* pt. 2, p. 528, pl. xxxi. fig. 7 (1876); *Buchholz, Crust. in Zweite deutsche Nordpolarf.* p. 375, pl. xiii. fig. 1 (1874).

Ampelisca ingens, *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 92, pl. xv. fig. 2 (1862).

A mutilated specimen is in the collection, dredged off Hare Island in 30 fathoms, with the greater number of the species collected. Its range extends from the Scandinavian seas, through those of Iceland and Greenland, to the coasts of Labrador and the Grand Manan.

EUSIRUS CUSPIDATUS.

Eusirus cuspidatus, *Kröyer, Nat. Tidsskr.* 2 R. i. p. 501 (1844–45); *Voy. en Scand.* pl. xix. fig. 2; *S. Bate, Cat. Amphip. Crust. Brit. Mus.* p. 154, pl. xxviii. figs. 6, 7 (1862); *Buchholz, Zweite deutsche Nordpolarf. Crust.* p. 313, pl. iii. fig. 2 (1874); *Boeck, Skandin. og Arktiske Amphipoder,* pt. 2, p. 502 (1876); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4) xix. p. 137 (1877).

A single individual (female with ova) was dredged off Hare Island. It has been found in the seas of Scandinavia, Spitzbergen, and Greenland.

CAPRELLA SEPTENTRIONALIS.

Squilla lobata, *O. Fabr. Fauna Grœnl.* p. 248 (1780), *nec Müller.*

Caprella septentrionalis, *Kröyer, Nat. Tidsskr.* iv. p. 590, pl. viii. figs. 10–19 (1843); *Voy. en Scand.* pl. xxv. fig. 2; *S. Bate, Cat. Amphip. Crust. B. M.* p. 355, pl. lvi. fig. 3 (1862); *Boeck, Skandinav. og Arktiske Amphip.* p. 696 (1876).

Caprella cercopoides, *White, in Sutherland's Journ., Crust.* p. 207 (1852).

A large number of specimens were dredged from a boat at Noursak at about 20 fathoms. It is probably common in the seas of Scandinavia, Spitzbergen, and Greenland.

CYAMUS NODOSUS.

Cyamus nodosus, *Lütken, Kong. Dansk. Vidensk. Selsk. Skrift.* 5 R. x. p. 274, pl. iv. fig. 8 (1873).

A large number of specimens, including males, females, and young, of this parasite of the Narwhal (*Monodon monoceros*) were

obtained of a Danish sailor at Umenak, who stated that they were parasitic on the nose around the horn, and that they were found only at Umenak; but this is certainly erroneous.

Cyamus monodontis.

Cyamus monodontis, *Lütken, l. c.* p. 256, pl. i. fig. 2 (1873).

This species, like the *C. nodosus*, is parasitic on the Narwhal, but only a few specimens obtained with the preceding have been preserved. These are very easily to be distinguished by the broader, more flattened segments of the body, which are not roughened and longitudinally sulcated as in *C. nodosus*, and the coxæ of the joints of the fifth to seventh legs are not armed with a spine as in that species. Some of the examples collected are, moreover, larger than any of *C. nodosus* obtained by Mr. Whymper.

Phyllopoda.

Branchinecta arctica.

Branchipus (Branchinectus) arcticus, *Verrill, Amer. Journ. Sci. & Arts* (ser. 2), xlviii. p. 253 (1869); *Miers, Ann. & Mag. Nat. Hist.* (ser. 4) xx. p. 105, pl. iv. fig. 1 (1877).

Branchinecta arctica, *Packard in Hayden, U. S. Geol. & Geogr. Survey*, p. 621 (1874); *Amer. Naturalist*, xi. p. 53 (1877).

A good series of specimens, males and females (several fully grown), were taken by hand by Mr. Whymper in stagnant pools near Godhavn Harbour. They agree very well with Verrill's original description (which I had not seen when I wrote the Report on the Crustacea of the Arctic Expedition last year); the second joint of the claspers in the male are bluntly pointed at the tip. They are even larger than the specimens collected by Verrill, attaining a length of 23 millims.

The examination of this series has shown that of the few individuals collected at Discovery Bay, none are nearly fully-grown, nor are there any females among them. It is not impossible that they may prove to be a distinct species, as suggested by me in my Report, on account of the straighter claspers (the basal joint of which has fewer teeth, and the second is less slender), the shorter, broader-lanceolate caudal appendages, &c.; but more and larger specimens are needed for comparison. In the specimen figured by me the male genital appendages are incorrectly drawn. The ovary is very long and narrow, considerably exceeding half

the abdomen in length, and so different from that of *Branchipus* (*B. stagnalis*) that I cannot doubt of the generic distinctness of *Branchinecta*. The terminal joint of the claspers in the female is very much abbreviated. The external male genital appendages are slender, and armed with a curved spine-like fleshy process near the base.

Copepoda parasitica.

Caligus curtus, *Müller*.

Caligus curtus, *O. F. Müller, Entomostr.* p. 130, pl. xxi. figs. 1–2, ♀ (1785); *Kröyer, Nat. Tidsskr.* i. p. 619, pl. vi. fig. 2 (1837); *Steenstrup & Lütken, Dansk. Vidensk. Selsk. Skr.* (5) v. p. 363 (1861); *Olsson, Prodr. Copepod. parasitant. Scand., in Acta Universitat. Lund.* p. 6 (1868), ubi synon.

Several specimens, including both males and females, were taken from a species of Cod caught by line in 100 fathoms in the North Sea in lat. 58° 53′ N., long. 1° 2′ E., and, unlike the *Laphystius sturionis*, occurring on the same fish, this species was distributed over the whole body of the animal.

Dinematura ferox.

Dinematura ferox, *Kröyer, Nat. Tidsskr.* ii. p. 40, pl. i. fig. 5 (1838–39); *Steenstrup and Lütken, Dansk. Vidensk. Selsk. Skrift.* (ser. 5) v. p. 376, pl. vii. fig. 14 (1861); *Olsson, Acta Universitat. Lundensis,* p. 17 (1868).

Three specimens were obtained in the rich haul off Hare Island, and two were taken from the "Greenland Shark" at Umenak. Mr. Whymper notes that they are usually, but not always, found attached to the eyes of the fish. The specimens are in fine condition.

Lernæopoda elongata.

Lernæa elongata, *Grant in Brewster's Edinb. Journ. of Sci.* vii. p. 147, pl. ii. fig. 5 (1827).

Lernæopoda elongata, *Nordmann, Mikr. Beitr.* p. 99 (1832); *Kröyer, Nat. Tidsskr.* i. p. 259, pl. ii. fig. 12, pl. iii. fig. 3 *a–k* (1837); *M.-Edw. Hist. Nat. Crust.* iii. p. 515 (1840); *Baird, Brit. Entomostraca,* p. 333, pl. xxxv. fig. 5 (1849); *Steenstrup & Lütken, Vidensk. Selsk. Skrift.* (ser. 5) v. p. 422, pl. xv. fig. 37, ♂ ♀, yg. (1861); *Olsson, Copepod. Scandinaviæ, in Acta Universitat. Lund.* p. 37 (1868).

Four female specimens in fine condition of this well-known

species were bought of a Danish sailor at Umenak, who had taken them from the "eye of the Greenland Shark," the situation in which they are always parasitic.

A specimen of a second small species of this genus is in the collection, said to have been taken from the gills of a Trout, and closely allied to, if not identical with, *L. salmonea* or *L. Edwardsii*; as, however, it is in imperfect condition, and the *bulla* terminating the arms is wanting, it cannot be identified with certainty.

Appendix.

Notice of two Additional Species collected during the British Arctic Expedition in 1875–76.

A box containing Invertebrata collected by naturalists of the late British Arctic Expedition was brought to the British Museum, after the various groups had been distributed to the naturalists entrusted with the working out of the collections, and after my report on the Crustacea had been published. It contained several species from Discovery Bay, among them some additional specimens of *Munnopsis typica* dredged in 30 fathoms, and the following species, which were not represented in the collections previously examined.

Nymphon robustum.

Nymphon robustum, *Bell, in Belcher, Last of the Arctic Voyages,* ii. *Crust.* p. 409, pl. xxxv. fig. 4 (1855).

A single individual (adult female with ova) was taken at Discovery Bay, in 30 fathoms, off specimens of Crinoids, which I do not hesitate to refer to this species. It is of large size (length between legs when fully extended nearly 4 in.). It is distinguished from *N. hirtum*, which occurred abundantly in the same locality, and more particularly from the variety described by me (Ann. Nat. Hist. 1877, xx. p. 109, pl. iv. fig. 3) as *obtusidigitum*, by the *chelæ*, which have the palmar portion very short and globose, and the fingers long, slender, arcuated, and acute at the tips. Moreover, the whole animal is clothed with a pubescence so short as to be scarcely discernible by the naked eye (on which account, I suppose, the legs are described by Bell as "quite naked"), while in *N. hirtum* and *obtusidigitum* the hairs that cover the animal are long. Bell's examples were obtained in Northumberland Sound, in 33 fathoms.

Balanus crenatus.

Balanus crenatus, *Bruguière, Darwin, Monogr. Cirripedia, Balanidæ*, p. 261, pl. vi. fig. 6 (1854).

I refer here, but with some hesitation, a small specimen collected in Discovery Bay at 30 fathoms. The shell is regularly and steeply conical, white, the compartments smooth, without longitudinal carinæ, except one, rather obscure, on the carinal valve; the radii are very oblique, the opercular valves much thinner than is usual in *B. crenatus*; the *scutum* has, however, scarcely any trace of an adductor ridge, and the spur of the *tergum* is rounded, but rather longer than in Darwin's figure of that of *B. crenatus*, and placed at rather less than its own width from the horizontal angle. The walls of the shell are internally ribbed. Specimens of *B. porcatus* were collected at the same locality in 20 fathoms.

On a Synthetic Type of Ophiurid from the North Atlantic. By Prof. P. Martin Duncan, F.R.S., F.L.S., &c.

[Read December 4, 1879.]

(Plate III.)

There is a very remarkable Ophiuran which forms part of a collection obtained by Dr. Wallich, during his voyage in H.M.S. 'Bulldog' in the year 1860, off the coast of East Greenland. The Ophiuran was presented by him to the Royal Microscopical Society, and I have been permitted to examine and describe it.

At first sight, the little form might be considered to be an Amphiuran of the *Hemipholis* group, but a glimpse at the upper part of the disk and at the sides of the arms discovers a spinulose condition of the upper surface of the first and a hooked arrangement of the latter structures. The resemblance to species of *Ophiothrix* then becomes more or less striking; but the large scaling of the disk, the absence of the tooth-papillæ, and the presence of accessory pieces around the aboral edge of the upper arm-plates are distinctive characters, which are, to a certain extent, suggestive of Ophiolepian and Ophiopholian affinities. Nevertheless the dental apparatus does not resemble that of these last genera. There is much in the form under consideration which recalls the shape and spinulation of *Ophionyx*, M. & T.; but the absence of tooth-papillæ and the presence of accessory plates to, and

spinules on, the upper arm-plates removes the form from that doubtful genus.

Description.—The length of the specimen is $\frac{3}{10}$ inch, and the body is $\frac{1}{12}$ inch in diameter.

The disk is circular in outline, is swollen inferiorly in the interbrachial spaces, and is slightly tumid on the upper surface.

The radial shields are small, longer than broad, broadest aborally, and they are separated orally by one or two plates. A central rosette of six subequal plates has the central one pentagonal in shape, the others being more or less rounded. Around the rosette is a row of alternately large and small plates; the smaller fit in between the radial shields, and the others cover much of the interradial spaces, there being only another row reaching to the margin of the disk. A microscopic, transparent, cellular scaling covers the plates of the disk and the spaces between them. There are no long spines to the disk nor accessory scales; but the radial shields are covered with short, broad-based, bulging, conical spinules, terminating in three small glassy thorns. Similar spinules exist on the edges of all the plates of the rosette, and rarely on the minutely scaled derm between them, and also, usually, on the plates which separate each radial shield from its fellow. The spinules increase in number towards the margin of the disk and become crowded there.

Beneath the disk and in the interbrachial spaces the spinules are there abundant, and they are close externally, but rarer near the mouth-shields. A small scaling separates the mouth-shields from the spinulose part, and there are no large plates on the under-part of the disk, which appears to be covered with skin.

The generative slits, two in each space, are large and wide, and reach to the sides of the mouth-shields.

The mouth-shields are small, more or less irregularly lozenge-shaped, broader than long, the aboral edge being broadly curved or produced into a blunt angle, and the oral angle being more acute and less pronounced. The madreporic shield is more rhombic in shape than the others. The side mouth-shields are small, narrow, slightly enlarged at the ends, and the oral margin is slightly concave; they do not quite unite within, and they do not reach far across, below the arm-plate.

The jaws are short and stout, separated slightly, and each angle is widely apart from its neighbours.

There are no true mouth-papillæ, but a small flat spine with a ragged top is situated on the side mouth-shield close to the

jaw; it projects downwards and outwards, and is in relation to the tentacle-opening. The jaws are swollen just externally to the very distinct jaw-plate. The true teeth are five in number, and the lowest is small and knobbed; it aborts in some angles; the next is long, broad and concave orally; and the others are shorter, flat, and slightly rounded where free. There are no tooth-papillæ, neither are there mouth-papillæ on the sides of the jaws.

The first upper arm-plate is small, broader than long, widest and curved distally, and narrower near the disk; it has spinules on it resembling those on the disk. The second plate is larger than the first, is about as broad as long, is broadest distally, the edge being curved outwards. The sides slope in towards the short oral edge, and the whole plate is convex from side to side; it has a few spinules on it in some instances. There are several (five) small accessory plates which are attached to the curved distal edge, and each one carries a spinule. An accessory plate is also on each side of this upper arm-plate near the proximal edge. The third upper arm-plate is longer than broad and is narrowest proximally; the accessory plates are in contact with its distal edge, and there is a knob on each side near the proximal edge, but it is not thorned. Three accessory plates are found in relation to the next plate and to the eighth; they are not fixed on to the edges, for they separate readily. The side knobs are found on these plates also, and usually there is a thorn on each.

The first lower arm-plate is very small, rounded distally, and is prolonged towards the mouth upwards, and it bounds part of the wide space between the jaw-angles; the second is much larger, and is square with a slight re-entering aboral curve; the outer angles are rounded, and the inner are incurved for the passage of the tentacle and the incoming of the side arm-plate. The next plates are longer than broad, are broadest without, have a more or less straight edge distally, and the oral edge is narrow and rounded; far out on the arm they are longer than broad.

The side arm-plates are stout, long, tumid at the sides when seen from above, and the spines project at right angles from them. The plates encroach on the upper arm-plates, but do not meet along the median line. On the lower surface of the arm they form stout processes, which reach nearly, but not quite, to the median line and form much of the surface. They form large flaps on the sides of the arms, and their free and spined distal edge projects outwards beyond the narrow proximal edge of the plate beyond.

The arm-spines are usually four in number, and the upper and lower are the smaller. All are rather short, none being longer than a lower arm-plate, and they are cylindro-conical, constricted at the base and bulging above it, and thence tapering to the end. They are serrate and have large terminal, and occasionally lateral, glassy thorns, and they are striated longitudinally. The lowest spine of the third or fourth side arm-plate has a large thorn on one side, and this is larger on the spine of the next plate; still further out this lateral thorn becomes a curved hook; and at the seventh or eighth plate there is a double transparent claw forming part of a hooked spine; these hooks are large and are continued to the end of the arm.

One tentacle-scale is seen on the arm, and it is large, thin, ragged and spinuled at the free edge, and it is longer than broad. There are no tentacle-scales within the angles of the mouth, and the first is thus absent.

This remarkable Ophiuran came up with the sounding-apparatus from off the sea-floor at a depth of 228 fathoms, about 50 miles north and east of Cape Valloe, East Greenland, and about 200 miles from Cape Farewell, date July 19, 1860, North latitude 60° 42′, longitude 41° 42′ W. Dr. Wallich informs me that the "cup" came up full of fragments of granite and felspar, to which were adherent small corallines. Some of them were very delicate, and their perfect condition indicated an undisturbed state of the bottom water where they occurred. There was a sudden decrease of depth close to the spot, and the water shallowed 578 fathoms in three miles.

Although a young form, this specimen presents the normal structures of an Ophiuran, and it is in no way deformed or abortive. The extreme simplicity of the oral apparatus is in itself remarkable: there are true teeth, but the spines on the side mouth-shields are the only mouth-papillæ, and they are so called because it is the fashion, erroneously, so to call all growths from the sides of the jaw-angles and side mouth-shields. The use of the small spines on the side mouth-shields is that of tentacle-scales, and they can have nothing to do with alimentation. This remark holds good in the majority of instances where the spine arises from the jaw, close to the side mouth-shield and tentacle-opening.

There are no tooth-papillæ, and the knob-like projection within the jaw-plate beneath the true teeth, so like that of some Amphiurans, is not seen on all the angles. It comes doubtfully, however, within the description of mouth-papillæ, and appears to be a true

tooth. The regularity of the pentagon surrounding the oral apparatus is very striking, and so is the extreme separation of the jaw-angles, much of which, however, may be due to *post mortem* contraction. All the plates on the upper surface of the disk have separate, broad-based, two- or three-thorned, short spinules on their edges and rarely elsewhere, but the spinulation is not distinct between them. The radial shields have the greatest number of spinules on them. All the spines on the side arm-plates project at right angles to the arm, and the hooks are glassy at their top. The combination of Amphiuran characters and those of *Ophiothrix* is thus remarkable.

Müller and Troschel established the genus *Ophionyx* and gave its diagnosis in their 'System der Asteriden,' 1842. It has the disk furnished with isolated many-thorned spinules, the mouth has only tooth-papillæ, there are two generative openings in each interbrachial space, and the arm is furnished beneath with echinulate spines and hooks. *Ophionyx armata*, M. & T., is delineated by them and *O. scutellum*, Grube, is noticed. This genus can hardly be separated from *Ophiothrix*; and although *Ophionyx armata* is not without the aspects of the form now under consideration, the structural distinctions of the absence of tooth-papillæ and the presence of accessory plates to the upper arm-plates are incompatible with the union of the species under one genus.

The genus *Ophiopholis*, Müll. & Trosch., has the upper arm-plates surrounded by a rim of minute accessory plates, and the lower spine of the under arm-plates is a hook; moreover, the disk is more or less covered with grains or little spines*. There are mouth-papillæ on the sides of the jaw-angles. In *Ophiolepis*, Müll. & Trosch., the disk has naked plates or scales, there are small accessory scales on the disk and arms, a row surrounding the disk-plates; there are mouth-papillæ, and the arm-spines are arranged along the outer edge of the side arm-plates, and there are usually two tentacle-scales. It is evident, as was suggested at the commencement of this communication, that the alliances of the form are more with these last two genera, but still the distinctness is decided. The extreme simplicity of the dental apparatus, there being no tooth- or mouth-papillæ on the jaw-angles, only a spine on the side mouth-shield or arising from its junction with the jaw, and evidently a tentacle-scale, is remarkable; the true teeth are well developed. The disk is symmetrically plated, spinules

* See Lütken, Addit. ad hist. Ophiurid. p. 11, pl. ii. fig. 16*a* (1861).

being between and on the plates in small numbers, but no accessory plates exist on it; beneath, the disk is covered with skin Spinules are found on the upper part of the arm, and the first and second upper arm-plates are spined. The spines of the side arm-plates project, and there are hooks; there is one tentacle-scale. These characters distinguish the form, and necessitate its entry into a new genus, *Polypholis*. The species is *Polypholis echinata*.

DESCRIPTION OF PLATE III.

Fig. 1. The disk and part of the arms from above, magnified.
2. The disk from below, magnified.
3. The spinules from the disk, magnified.
4. The arm spines and hooks, magnified.
5, *a*, *b*, *c*. The tentacle-scale, magnified.
6. Diagram of the mouth-shield, side mouth-shield, and angle of jaw.
7. *Polypholis echinata*, nat. size.

On the Hebridal Argentine. By FRANCIS DAY, F.L.S.

[Read March 4, 1880.]

(PLATE IV.)

ARGENTINA SPHYRÆNA.

Sphyræna parva, Rondel. i. p. 227, c. fig.; Gesner, pp. 883, 1061.

Argentina, Willughby, p. 229; Ray, p. 108; Artedi, Synon. p. 17, and Genera, p. 8.

Argentina sphyræna, Linn. Syst. Nat. i. p. 518; Gmel. Linn. p. 1394; Risso, Ichth. Nice, p. 336, and Europ. Mérid. iii. p. 462; Cuv. Mém. Mus. i. p. 228, pl. xi.; Nilsson, Skand. Fauna, Fisk. p. 476; Günther, Catal. vi. p. 203; Collett, Norges Fiske, p. 171.

Argentina silus, jun., Nilss. Obs. Ichth. 1835, pp. 3–7.

Osmerus hebridicus, Yarrell, Supp. Brit. Fishes, and ed. 2, ii. p. 133; Rudd, Zoologist, 1852, p. 3504; White, Catal. Brit. Fish. p. 79.

Argentina Cuvieri and *Yarrelli*, Cuv. & Val. xxi. pp. 413, 418.

Argentina hebridica, Nilss. Skand. Faun., Fisk. p. 474; Yarrell, Brit. Fishes (ed. 3), i. p. 300; Günther, Catal. vi. p. 203.

Hebridal Smelt, Couch, Fishes of the British Isles, iv. p. 297.

Argentina decagon, Clarke, Trans. & Proc. New Zealand Institute, 1878, xi. p. 296, pl. xiv. f. 2.

Stromsild, Christiania.

B. vi. D. 10 ($\frac{2}{8}$). P. 14. V. 11. A. 12 ($\frac{3}{9}$). C. 19. L. l. 52. L. tr. $\frac{3}{\frac{1}{4}}$. Cæc. pylor. 5.

Length of head $4\frac{2}{3}$, of caudal fin $7\frac{1}{2}$, height of body $6\frac{1}{2}$ in the total length. *Eyes* with moderately wide adipose lids, the anterior of which rather overlaps the posterior above the centre of the upper edge of the orbit; diameter of eye $3\frac{1}{2}$ in the length of the head, 1 diameter from the end of the snout and also apart. The shape of the fish is as follows:—The back, sides, and abdominal surfaces flattened, so as to give it a general tetragonal form, these various surfaces being divided one from the other by a well-developed ridge. These four flat surfaces are further subdivided by other parallel ridges, one of which is a short distance internal to the upper orbito-caudal ridge; a second a little above the pectoro-caudal ridge. In addition to these four secondary ridges, there exists another short one from the lower edge of the base of the pectoral fin to the ventral. Snout conical and somewhat depressed; upper surface of the head flat, its sides compressed. Upper jaw slightly longer than the lower; the maxilla scarcely reaches above two thirds of the distance to beneath the front edge of the eye. The suborbital ring of bones, the præopercle, opercle, and upper portion of the subopercle with a rather thick adipose covering. *Teeth*: none in the jaws; an arched row of small ones across the head of the vomer, and continued on to the anterior and contiguous portion of the palatines; a single row of eight large and somewhat recurved ones are placed on the upper surface of the front portion of the tongue. *Gill-rakers* rather widely separated, thick, and the longest about one fourth the diameter of the orbit in length. *Fins*—First dorsal as high anteriorly as the body beneath it, its posterior rays about two fifths the height of its front ones; adipose fin placed above the last anal rays; pectoral if turned forward reaches the middle of the eye; ventral inserted in the middle of the distance between the end of the snout and the base of the caudal fin, while it is beneath the last dorsal ray; anal highest anteriorly, where it equals the length of the base of the fin; caudal forked. *Scales* large, thin, higher than long; those along the back adherent, those on the sides more deciduous. Minute ossicles, having a stellate or spinate form, exist on the scales of the back, and also on some of those in the abdominal region. The row of scales immediately beneath that of the lateral line is the largest; most have somewhat crenulated edges. *Lateral line* on a row of smaller scales, well marked, and passing to the centre of the base of the caudal fin. *Cæcal appendages*—five long ones, loaded with fat. The example is a male, full of milt. *Colours*—of a light olive along the back, becoming silvery

white on the sides; a black spot at the upper edge of the orbit and a smaller one on the snout; a darkish longitudinal mark along either lobe of the caudal fin near its outer edge.

I now propose considering whether *Argentina sphyræna*, Linn., and *A. hebridica*, Yarrell, are or are not identical, and which Collett, as I believe, with good reason states they are. Valenciennes gives the formula thus:—

Argentina sphyræna......	D. 10.	A. 12.	V. 10.	P. 12.
A. hebridica	D. 11.	A. 12.	V. 11.	P. 14.

But these numbers evidently are subject to great variation; and no undoubted criterion can be deduced from the number of fin-rays or scales. Nilsson found from 14 to 20 cæcal appendages in *A. hebridica*, whereas *A. sphyræna* is said to have only 12. If so great a variation as 6 can occur in one undoubted species (especially as the present example had only 5 long ones), it would be hazardous to consider that these variations in number are sufficient to constitute distinct species.

The principal difference pointed out in the British-Museum catalogue is that in *Argentina sphyræna* the height of the body is 8 in the total length, while in *A. hebridica* it is $5\frac{1}{2}$ (this should be $5\frac{7}{9}$). The following are the proportions of some I have examined or obtained the accurate dimensions of, as Collett has stated that the proportionate length to height varies with age; fractions are omitted if very trivial:—

1 from	Sicily 5	inches long,	height	1 in 8	of total length.	British Museum.
1 „	Norway .. 6	„	„	1 „ 8	„	Collett.
1 „	Bute.........$6\frac{1}{2}$	„	„	1 „ $5\frac{7}{9}$	„	Yarrell.
1 „	N. Zealand 6·9	„	„	1 „ 7	„	Clarke.
1 „	? 7	„	„	1 „ $7\frac{1}{2}$	„	British Museum.
1 „	Nice.........7·3	„	„	1 „ $6\frac{1}{2}$	„	British Museum*.
1 „	Norway ...$8\frac{1}{2}$	„	„	1 „ 6	„	Collett.
1 „	Skye.........$9\frac{1}{2}$	„	„	1 „ $6\frac{1}{2}$	„	Day.

There can be no doubt but that my Skye example agrees with Yarrell's, wherein he found the height as 1 in $5\frac{7}{9}$, but does not distinctly say whether his specimen was a skin or in spirit. Valenciennes states his examples of the same species were 1 in 8 of the total length, or similar to what he found existed in *A. sphyræna*. As we see in those examples which have been preserved in alcohol, some the height of whose body is 6, others $6\frac{1}{2}$, 7, or 8, in the total length, it is evident that this proportion varies, and

* The length of the caudal fin is deduced from the average of other specimens, as this fin is often broken in museum examples.

cannot be taken as a means for the discrimination of the two so-called species, which must be considered as one.

There is one subject respecting the air-bladders of the fishes of this genus which is of great interest, belonging, as they do, to the family Salmonidæ, wherein this organ is of the Physostomous variety, but destitute of any chain of ossicles connecting it with the internal ear, as seen in the true freshwater Cyprinidæ, Characinidæ, and Siluridæ*. Valenciennes mentions that the museum at Paris had received a very good example of *Argentina silus*, a little more than a foot in length, from the Bergen Museum. He supposed that it had been captured at a great depth, for its stomach was inverted. This inversion of the stomach is observed in fishes suddenly brought up from great depths; and is known to be caused by the pressure of the water being rapidly lessened or entirely removed, causing the gases in its interior to expand and either burst the air-bladder or force the stomach into the mouth. I do not think this phenomenon has been observed in Physostomous fishes, to which the Salmonidæ belong, as the pneumatic tube, which is pervious throughout life, acts as a safety-valve, and would permit this rapidly expanding gas to find an exit by the alimentary canal. This brings us to the question of whether the Argentines are or are not Physostomi, the same as the remainder of the Salmonidæ. Valenciennes states that they belong to the Physoclisti, as, so far as he could ascertain in three well-preserved examples, no pervious pneumatic tube could be detected.

If the Argentines undoubtedly belong to the class of fishes having closed air-bladders, it is an exceedingly interesting fact—one, however, I have as yet had no opportunity of investigating. The genus *Salmo* contains fish, some of which are anadromous, others freshwater; but their affinities are unmistakably marine. And here we observe another link in finding *Atherina*, one of the deep-sea Salmonidæ, possessing a closed air-bladder smaller than perceived in other genera of the same family, perhaps due to the depths at which it resides. For were it large and of the Physostomous type, probably it would be unable to keep it distended with gas, as such would be pressed out through its pneumatic tube, unless the same mechanism were adopted as we see in the

* Physostomous fishes are mostly freshwater forms, having a chain of ossicles as described; or if marine, they are mostly surface-swimmers or littoral species, with a tubular prolongation of the air-bladder instead of a chain of ossicles. Physoclistous fishes appear to be, as a rule, marine or of marine origin.

ground-feeding Loaches and some of the Siluroids, where this organ is protected from pressure by being enclosed in bone by a development of the parapophyses of the anterior vertebræ.

We find a figure and description of this species in Rondelet's Marine Fishes, which was reproduced by Gesner. Willughby gives "*Pisciculus* Romæ *Argentina dictus. Sphyræna parva sive Sphyrænæ secunda species*, Rondeletio Gesner 1061,"—very clearly indicating that this author referred to the fish described by Rondelet and Gesner; while it was likewise his Roman deep-sea fish from whose air-bladder materials were obtained for the manufacture of artificial pearls. Ray copies almost verbatim from the authors I have quoted. Doubtless Artedi's species was identical with *Argentina sphyræna* of Linnæus, but not with Gronovius's fish. Risso, in his 'Ichthyology of Nice,' refers to the same fish, under Linnæus's name, as being captured throughout the year in the sea, as well as to its air-bladder being employed in artificial pearl-making. The synonyms I have given likewise show how it has been observed upon by Cuvier, Nilsson, Yarrell, Valenciennes, &c., the last-mentioned author, as is well known, having a partiality for changing specific names. Thus he gives *Argentina sphyræna* of Linnæus and Cuvier as *A. Cuvieri*, admitting the two to be identical: and he changes *Osmerus hebridicus*, Yarrell, into *Atherina Yarrelli*.

Up to the present time I have only been able to find three British examples of this fish recorded, and all mentioned by Yarrell. Two were from the S.W. coast of Scotland, where the fishermen reported it as well known, but rarely seen: one of these was $8\frac{1}{2}$ inches long, taken in 1836, full of roe, in the bay of Rothesay, Isle of Bute; the second, $6\frac{1}{2}$ inches in length, in November 1837 near the same spot, on a hand-line baited with a piece of mussel, and in 12 fathoms of water, about 200 yards from the shore. The third, of which I have been unable to obtain any description, came from the German Ocean off Redcar, in Yorkshire, where it was obtained by Mr. Rudd, who showed it to Mr. Yarrell.

Couch, when he published his work on the Fishes of the British Isles in 1862, did not appear to have met with the species, although he observes that it "is not rare in the sea near the islands to the north of Scotland," but omits giving his authority for the statement. He likewise remarks, "I am informed by Mr. John Iverach of Kirkwall, in Orkney, that it is not known to the fishermen of that island." Four years subsequently (1866) Dr.

Günther, in the 'Catalogue of the Fishes of the British Museum,' vi. p. 203, quotes "*The Argentine*, Low, Fauna Orcadensis, p. 225," as a synonym of *Argentina hebridica*, which reference, were it correct, would show that both Yarrell, Couch, and other antecedent authors had been in error in believing that this fish had not, previously to the capture of the Bute example in 1836, been recorded from the British seas. On referring, however, to Low, it will be seen that he terms his single example of an Orkney fish (which was not above an inch in length) "*the Argentine*," and refers to Pennant, who applied this name of *Argentine* to the *Maurolicus borealis*, pertaining to the family of Sternoptychidæ; and Low's references to Willughby, Ray, and Linnæus may have been copied from Pennant's 'British Zoology.' Irrespective of this, in vol. v. p. 389 of the British-Museum catalogue, Low's single specimen is also referred to *Maurolicus borealis*, while it is manifestly impossible that one fish can pertain to two distinct families.

The example I have to record is one of 9·5 inches in length, in a good state of preservation, having been placed in whiskey immediately after it had been captured. It was taken in October 1879, near Lochalsh, off the Skye shore, by a fisherman using a hand-line, the hook being baited with a piece of mussel; its captor considered it very rare, stating that he had only once previously taken an example. Not only is the specimen an interesting one, but likewise the locality from which it was received, the N.W. coast of Scotland, showing that it is by no means improbable that it may exist all round that country.

The Argentine is found extending from the shores of Norway to those of the west coast of Scotland and the German Ocean on the east coast of Yorkshire; thence through the Mediterranean to the Balearic Isles and along the southern shores of Europe, being taken, we are informed, all the year round in the sea off Rome; while most authors state it to be a deep-sea fish.

Mr. Clarke has described and figured *Argentina decagon* from New Zealand, where a unique example was procured, and which does not differ from my specimen, except that it is stated to have four rows of scales between the lateral line and base of the dorsal fin, whereas I only count three. At first sight it would seem strange that this species could stray from the North Atlantic to the South Pacific ocean, even if we accepted Mr. Clarke's suggestion that "it would be of excessive interest to have more proof than mere imagination that our antipodean species had gradually worked its way '*sub mari*' in those cold lower strata of water to

our coast." Several European species of fish have been found existing in more or less plenty in that portion of the world and in Tasmania—as Chondropterygian fishes destitute of air-bladders, and *Sciæna aquila*, *Zeus faber*, and *Trachurus trachurus* (species with the air-bladder of the Physoclisti type), all of which, we might perhaps imagine, could work their way "*sub mari*" in a colder stratum of the water. But *Clupea sprattus* and *Engraulis encrasicholus* (var.), physostomous surface-swimming European forms, have likewise been taken in Tasmania; and it does not seem credible that such forms would live at great depths in the tropics and travel in safety through the warmer regions of the globe, to pass from the North Atlantic to the South Pacific ocean. Whatever the explanation may be, the fact remains; and to the European forms of fish which have been recorded as existing in the antipodes, the *Argentina sphyræna* must be added.

[Since the foregoing paper was read, Professor Giglioli has published the following remark in his 'Catalogo degli Anfibi e dei Pesci Italiani,' under the head of *Argentina sphyræna* :—"Non frequente, ma neppure rara; così sul mercato di Roma nel gennaio 1879 ne ho veduto ceste piene. Credo poter affermare che, se basata sulla mancanza di denti linguali, l'*A. lioglossa*, C. e V. va cancellata, giacchè nella serie raccolta a Messina si vede ogni possibile gradazione nelle sviluppo di quei denti ed alcuni esemplari ne sono privi senza per altro differire dagli altri."]

EXPLANATION OF PLATE IV.

Fig. 1. *Argentina sphyræna*, Linn., reduced.
2. Diagrammatic outline, transverse section of body.
3. Stomach and cæcal appendages.

Description of a new Genus of Moth of the Family *Liparidæ* from Madagascar. By Arthur G. Butler, F.L.S., F.Z.S., &c.

[Read April 1, 1880.]

The following new genus was received last year in a collection made by Mr. Shaw at Fianarantsoa, Madagascar; but I had at the time so strong an impression that I had somewhere seen a figure or a named example of the species, that I hesitated to describe it: it is probable that I had in my mind the New-World genus *Megalopyge* of the family Lasiocampidæ, which bears a vague resemblance to it in some respects. I now have no doubt

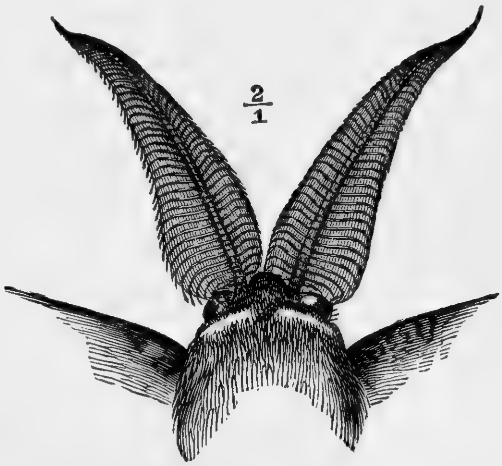
that the species is perfectly new, and that its structural peculiarities warrant its being regarded as the type of a hitherto unknown genus.

PYRAMOCERA, gen. nov.

Lymantriæ affine, costa autem alarum anticarum longiore, antennis longioribus, ad basin latioribus, gradatim ad apicem pyramidatis, pectinibus longissimis cirratis: corpus alæque subtus lanugineæ. Gen. typ. *P. fuliginea.*

PYRAMOCERA FULIGINEA, sp. n.

♂. Wings above smoky brown; primaries with a cuneiform white patch enclosing two black spots within the outer half of the discoidal cell; fringe spotted here and there with pale buff: thorax smoky brown; sides of stamen of antennæ and collar carmine, remainder of antennæ brown internally and testaceous externally; abdomen carmine, with a dorsal series of blackish spots; centre of anal tuft black. Wings below smoky brown, with the fringe as above: primaries with a spot on the costa and an indistinct interno-median streak pale yellowish; base of costa orange: secondaries with a whitish spot before the middle of the costa: body below black, an orange spot in front of each antenna; the palpi, legs, and venter banded with orange; collar carmine; femora carmine in front. Expanse of wings 3 inches 3 lines.



Head and antennæ. Twice nat. size.

Fianarantsoa. Type in Brit. Mus.

Notice of Crustaceans collected by P. Geddes, Esq., at Vera Cruz.

By EDWARD J. MIERS, F.L.S., F.Z.S.

[Read April 1, 1880.]

MR. P. GEDDES has kindly presented to the collection of the British Museum a few Crustaceans collected by him at Vera Cruz on the eastern coast of Mexico, which appear worthy of a notice in the Society's Journal. They include:—(1) a female

and immature male of a species of *Panopeus*, which at present can scarcely be determined with certainty; (2) three small examples of *Pachygrapsus socius*, Stimpson, which is very probably merely a variety of *P. transversus*, as it is distinguished only by the absence of the dark patch on the immobile finger, which is always present in the typical *transversus*; (3) a series of females of a species of *Pinnotheres*, which I identify, although with some hesitation, with *P. angelicus*, Lockington, and of which the following is a description:—

PINNOTHERES ANGELICUS.

P. angelicus, Lockington, P. Cal. Ac. Sci. vii. p. 154 (1876).

Carapace convex, smooth, shining, and naked, of a somewhat quadrate form, with rounded angles, the lateral portions of the cervical suture defining the gastric region usually distinct. Front rather broad, rounded or subtruncated anteriorly; its antero-lateral angles are prominent and dentiform. Merus joint of the outer maxillipedes robust, with the outer margin regularly convex; the inner margin with a bluntly rounded angle near the distal extremity; carpus and propodus thick and robust, the latter rounded and ciliated at its distal end; dactyl very slender, styliform (not at all spatulate), and about reaching to the extremity of the propodus. Anterior legs (in the female) slender, smooth, and unarmed; propodus enlarging slightly to its distal end; dactyl a little shorter than the superior margin of the propodus, and as long as the immobile finger; both meet along their inner margins when closed, and are clothed with a few hairs near the distal ends. The ambulatory legs are slender and naked, with the dactyli nearly straight; the penultimate joint of the first is not dilated distally, and the dactyl is very short; the dactyl of the second legs is nearly as long as the penultimate joint, that of the third and fourth pairs relatively a little shorter, the last-mentioned being thinly ciliated on its inferior margin.

Hab. Vera Cruz. (Several specimens, adult females with ova, were taken from oysters, but no males were observed.)

The specimens described by Mr. Lockington differ in having the sutures of the carapace wholly obsolete, and the dactyl of the anterior legs only half as long as the palm. If distinct, this species may be designated *P. Geddesi*. If it be not distinct, *P. angelicus* must be added to the rapidly increasing list of species occurring on both the eastern and western coasts of America; and *Pachygrapsus socius* has a similar distribution.

The specimens before me seem to be quite distinct from all the other American species of *Pinnotheres*. From *P. ostreum* they differ in the non-dilated penultimate joint of the first pair of ambulatory legs, and in the much shorter dactyli of the second ambulatory legs; from *P. maculatus* in the form of the carapace and the much shorter dactyli of the fifth ambulatory legs; from *P. Guérinii* and *P. hirtimanus*, M.-Edwards, both from Cuba, in the non-spatulate dactyl of the outer maxillipedes; and from the latter also in the non-ciliated inferior margins of the chelæ. *P. margarita*, Smith, from the Bay of Panama, is at once distinguished by its pubescent carapace and legs; *P. lithodomi*, Smith, from the same locality, by the form of the merus joint of the outer maxillipedes and the proportionate length of the dactyli of the ambulatory legs.

Mollusca of H.M.S. 'Challenger' Expedition.—Part V. By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S., &c.

[Published by permission of the Lords Commissioners of the Treasury.]

[Read April 15, 1880.]

Families and Genera.

Solenoconchia, viz. *Siphodentalium honoluluense* (omitted).
Trochidæ, viz. *Trochus* (omitted).
Heterophrosynidæ*, viz. *Jeffreysia.*
Litorinidæ, viz. *Echinella, Lacuna,* and *Fossarus.*
Cerithiidæ, viz. *Cerithium, Litiopa,* and *Cerithiopsis.*

This group of shells includes some inadvertently omitted before, two families sparingly and unsatisfactorily represented, and a considerable number of Cerithiidæ. They are chiefly from shallow water, and need little remark. I may therefore take the opportunity to say a word regarding the identification of 'Challenger' specimens with known species, a work already embracing over six hundred species, and now nearly completed. This work of identification, with the labour of hunting up references, even though no such exhaustive citation of authors as is suitable for a monograph of a limited group has been attempted, has been a

* This formidable name of Clerk's is adopted here in preference to Gray's name of *Rissoellidæ*, in deference to the arguments of Dr. Gwyn Jeffreys, who assures me, 1st, that Clerk's name has priority (of which I am not quite convinced); and, 2nd, that *Rissoella*, Gray, was founded on *Pyramis glabrus* (sic), Brown, "which is evidently an *Odostomia*."

very heavy task. From the study of this material a few points stand out with special prominence.

1. Depth is an important condition of molluscan life. That is to say, there really are shallow and deep water species and genera, though their bathymetric limits are not absolutely constant.

To some this may seem too self-evident and universally accepted a proposition to need statement. Such would have been the case some years ago; but dredgings from the deep sea have presented facts which demanded a revisal of received opinions on this point; and while the result in the main cannot be said ever to have been doubtful, and while the evidence of other branches of natural history has already been obtained in this same sense, it is desirable also to record the witness of the Mollusca of the 'Challenger' expedition.

2. Temperature, even more than mere depth, seems an important condition in molluscan life.

It is needless to speak here of other conditions, such as light, or food, or oxygen, because, though there are extreme differences in these respects, and though their influence must be very great, still their precise amount, and the nature and direction of their effects, are too little known to afford foundation for more than guessing.

Pressure seemed likely to form a very important condition in marine animal life; the enormous figures representing the square-inch amount of that pressure stirred men's imagination, and their fancies were supported by the fact that rapid transference to the surface from even a moderate depth destroys life; but these impressions were removed by a remembrance of the laws of hydrostatic pressure, and by substituting a gradual for a rapid transition from deep water to the surface. Temperature, however, remains as an undoubtedly important factor.

3. Great differences in these respects of depth and temperature prove barriers to distribution.

4. Great length of time naturally helps escape from these barriers, for in the lapse of years accidents are likely to occur enabling species to evade difficulties which would in ordinary circumstances prove insurmountable. Hence the finding of a living species in a fossil state will always justify the expectation of its having a wide local distribution.

5. Where barriers of depth and temperature do not check distribution, there seems, in ordinary circumstances, no limit to universality of distribution.

6. There actually are existing species whose distribution is universal, no barriers having availed against their passage.

7. Still there is no trace, even in these species, of essential, lasting, and progressive change.

I do not intend to overpress this point, for I allow that it presents merely negative evidence. I do not assert that there are *no* species of Mollusca which have essentially, permanently, and progressively changed. I only say there are some, even many, which have *not* done so, that I do not know any which have, and that the burden of proof lies with those who assert the positive. Evolutionists are in the way of saying that a thing being possible, is therefore probable, and consequently is true unless the contrary be proved. I only wish to note that this is a reversal of all the laws of evidence in any case of fact whatever, and to add that, so far as I have had opportunity of observation, no proof has reached me of progressive, permanent, and essential change in molluscan development.

In accomplishing so much as I have already overtaken, I have been aided kindly, often, and in many ways, by Mr. E. A. Smith, of the British Museum, who has, in the case of myself, as of many others, helped with his great knowledge of the Museum collection, and his large acquaintance with the literature of the subject. I very gladly take this opportunity also of offering my thanks to Dr. J. Gwyn Jeffreys, to Dr. H. Woodward, to Prof. Seguenza, to Prof. G. O. Sars, to Prof. v. Martens, to the Marquis de Monterosato, to Mr. William Dall, to Mr. Marrat, and to many other friends.

Siphodentalium, *Sars.*

8. *S. honoluluense,* n. sp.

8. Siphodentalium honoluluense, n. sp.

July 1875. Reefs off Honolulu. 40 fms.

Shell.—Cylindrical, bent and attenuated from about the middle to the apex, toward the mouth very slightly contracted; of a dull white translucency, and not glossy. *Sculpture.* The surface, especially toward the apex, is faintly marked by microscopic, remote, oblique, raised, encircling rings, parallel to which there are fine scratches in the intervals. *Edge* of the mouth very oblique, blunt. *Apex* not small, broken. Length 0·21; breadth, greatest 0·031, at mouth 0·028, at apex 0·016.

This species closely resembles *S. tetraschistum*, W.; but, besides the obvious difference in size, that species is a little more cylindrical and is much more strongly and uniformly sculptured. I say nothing of the peculiar feature of the apex of that species, because, the point being broken in the solitary specimen of the present species, comparison is impossible.

TROCHUS, *L.*

17. *T.* (*Gibbula*) *leaensis*, n. sp.
18. *T.* (*Ziziphinus*) *arruensis*, n. sp.
19. *T.* (*Solariella*) *philippensis*, n. sp.
20. *T.* (*S.*) *lamprus*, n. sp.
21. *T.* (*S.*) *albugo*, n. sp.

17. TROCHUS (GIBBULA) LEAENSIS, n. sp.

Oct.–Dec. 1873. Lea Point, Cape Town.

Shell.—Small, conoidal, scalar, having a rounded periphery, a flattened base, no umbilicus, and with purple spiral threads on a dull whity ground. *Sculpture.* The whole surface is longitudinally obliquely striate, in hair-like puckerings; of spirals there are on the last whorl above the corner of the mouth 7 purple threads; they are pretty equal, and are parted by furrows as wide as themselves; the third and fourth are somewhat stronger than the others, and the three last, at the periphery, are closer than the others. In some of the upper furrows traces of other fine spirals can be seen. Within the base lies one purple thread, and inside of this there are nine feebler, flatter, more crowded spirals, surrounding the closed, umbilical depression. *Colour.* A ruddyish white, with dark purple spirals above; those on the base, with the exception of the exterior one, being uncoloured; the apex is yellow. *Spire* conoidal, with a slightly raised rounded apex. *Whorls* 6, small, the last tumid, the earlier ones rounded, a little flattened below the suture; the embryonic whorls two, minute, smooth, rather immersed. *Suture* linear, but strongly marked by the angulation of the whorls. *Mouth* round, but pointed above, and with an angulation at either end of the pillar. *Outer lip* thin, sharp, and coloured by the purple spirals. *Inner lip* sharp, on the edge of the pillar, round which it is reflected and flattened, extending on the umbilicus in a small, thin, defined pad. There is a slight obtuse tooth near the front of the pillar. *Inside* dull, with a bright nacreous border within the dull extreme edge. *Umbilicus* closed, but with a marked depression. H. 0·2. B. 0·22, least 0·175. Penultimate whorl 0·065. Mouth, height 0·125, breadth 0·11.

In many respects this species is very like *T. zonatus*, Wood (= *T. menkeanus*, Phil.), but than that species this is much smaller and higher; the last whorl, which is the sixth in both, is here much smaller and narrower, and the umbilicus is not covered by the broad semicircular plate which characterizes that species. In that, too, the coloured bands above are fewer and are very unequal, and there are three of these on the base. *T.* (*G.*) *fulgens*, Gould, is not unlike, but is higher, and the spirals are more numerous and smaller.

18. Trochus (Ziziphinus) arruensis, n. sp.

Sept. 18, 1874. Arru Islands, S.W. of Papua.

Shell.—Conical, carinated, with a flattened base, strong, opaque, covered with tubercles, and coloured with grey and pink. *Sculpture.* There are eight spiral rows of small round tubercles on each whorl. The tubercles on the first two rows are larger than the others; these, as well as the next three rows, are parted by distinct depressions; the lowest three rows are much closer together, but project a little, especially the centre and largest row of the three. On the base there are about nine less strongly tubercled spiral threads, with feebler threads between, these intermediate threads becoming feebler towards the centre. The tubercles are smooth and polished, but the whole intervening surface is sharply fretted with fine oblique puckerings. *Colour* white, beautifully flecked above with greyish-purple blotches, and closely spotted with purplish pink on the base. *Spire* high and sharp-pointed, its concavely conical slope being slightly broken at the sutures by the projection of the two superior rows of tubercles. *Whorls* about 10, flat and of very regular increase. *Suture* slight, but distinct, being defined by the slight carinal spiral above, and the double row of larger tubercles below. *Mouth* rather small, square and very oblique. *Outer lip* sharp but strong. *Inner lip* strengthened internally by a buttress of porcellanous nacre, which ends abruptly towards the point of the pillar, forming a tooth. The pillar, bevelled off to a sharp edge, is pressed back on the umbilicus, which it completely closes, leaving only a central depression and a postcolumellar furrow. *Operculum* thin, yellow, normal. H. 0·64. B. 0·58, least 0·52. Penultimate whorl 0·18. Mouth, height 0·42, breadth 0·3.

This species very much resembles *T. decoratus*, Phil., but that species is more highly narrowly conical, is flatter on the base, and the whole system of spirals is different. In *T. decoratus* also the earlier

whorls are simply spiralled; here the spirals are cross hatched. *T. nobilis*, Phil., is much larger, is flatter on the base, and is not so closely spiralled. *T. euglyptus*, Ad., has the whorls much rounder.

19. TROCHUS (SOLARIELLA) PHILIPPENSIS, n. sp.

St. 161. April 1, 1874. Off the entrance to Port Phillip, Australia. 38 fms. Sand.

Shell.—Rather like *T. tumidus*, but with a broader base, more conical, and less scalar, with a large open umbilicus and brilliant colour. *Sculpture.* The shell is gathered into small regular flat puckers below the suture; these are weaker on the last whorl. The whole surface is covered with very fine oblique longitudinal striæ. *Spirals.* There are very numerous, fine, sharp, undulating scratches, which on the middle of the base are shallower and wider apart, but toward the umbilicus again become sharper and more crowded. Within the umbilicus are four or five somewhat beaded spirals, the first and strongest of which forms an umbilical carina. *Colour* faintly iridescent all over, creamy white, flecked with zigzag lines of crimson, which on the upper whorls are narrow and regular, on the penultimate whorl are remote, and on the last are irregular, broken, and crowded. On the base there are eleven to twelve elongated radiating crimson spots. The first three whorls are a pale orange-yellow. *Spire* rather high, scalar. *Apex* small, bluntly pointed. *Whorls* $6\frac{1}{2}$, with a flat shelf below the suture, angulated at about $\frac{1}{5}$ of their breadth, and rounded from the angulation to the suture. The last whorl is bluntly angulated at the edge of the rounded base. *Suture* strong, being slightly impressed and very distinctly marked by the angle at which the adjoining whorls meet. *Mouth* little oblique, round. *Outer lip* thin and sharp, not at all expanded. *Inner lip* thin and sharp, a very little patulous on the pillar, where it also retreats a little, so as to form a slight open sinus; brilliantly iridescent within. *Umbilicus* wide and pervious, and deeply impressed at the suture, which runs spirally up to the apex within. H. 0·275. B. 0·33, least 0·3 Penultimate whorl 0·085. Mouth, height 0·15, breadth 0·14.

Solariella is a MS. generic name of Searles Wood, published in his Catalogue of Crag Moll. in 1842, and suppressed by him as a mere synonym of *Margarita* in his Crag Moll. (Pal. Soc.) vol. I. p. 134. Adams revives it in his 'Genera' as a subgen. of *Monilea*, with which it has nothing specially to do; but it may not be amiss

to retain it for the Australian group of Trochidæ, whose brilliant colours distinguish them from the *Margaritas*. There is a *Margarita tasmanica* of Tenison Wood, from Bass Straits, which, from his description, seems to present some features of resemblance to this species; but he says of it that the upper part of the whorls is not angulated. Than *T. angulatus*, A. Ad., this Port Philip species is much larger and higher. It approaches most nearly to *T. bellula*, Ang.; but that is larger, with the same number of whorls, has a transparently white apex, has the shoulder below the apex not flat nor drooping outwards, but gouged out as a concave depression, the last whorl is more spread out, and the base is without colour, the umbilicus is wider and less deep, and the spiral which defines it is stronger, while there are no other spirals within it; the whole surface of the shell, too, is smooth, with a few strong clean-cut impressed spirals, instead of being closely and minutely fretted with spirals all over.

20. TROCHUS (SOLARIELLA) LAMPRUS, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Depressedly conoidal, angulated at the periphery, rounded on the base, umbilicated, polished, finely sculptured, solid. *Sculpture.* The glossy surface is closely fretted with fine, curved, oblique, longitudinal scratches, crossed by very similar but slightly stronger and more equal spirals; these both are stronger near the suture, and feebler on the base, where, indeed, the spirals almost disappear. *Colour* pellucid pale yellowish white, with many narrow, opaque, pure white spirals, which are flecked with fine zigzag brown longitudinal lines, aggregated in spots, and most abundant near the suture. The strongest opaque spiral is at the periphery, and on it are minute linear interruptions of the fundamental colour, and very regularly recurring little brown spots, which are about half the width of their interspaces. On the base the brown spots are very few and minute. There is very little iridescence anywhere. *Spire* low. *Apex* minute and projecting. *Whorls* 6, depressed, equally curved, slightly angulated at the periphery, more flattened on the base than above, of regular, but rather rapid increase. *Suture* slightly depressed. *Mouth* small, round. *Outer lip* thin and perfectly simple. *Inner lip* porcellanous, thick and flat, projecting in a minute ear across the umbilicus, and having toward the point of the pillar a broad backward bevel, cut out of the thickness of the shell round the umbilicus. *Umbilicus,* a shallow open depres-

sion, with a deep narrow hole in the centre. H. 0·15. B. 0·24, least 0·2. Penultimate whorl 0·05. Mouth, height 0·13, breadth 0·1.

The specimen from which this species is derived is not quite full-grown. The whorls are not angulated, nor the umbilicus open, nor is the colour ruddy, nor the texture thin, as in *T.* (*S.*) *angulatus*, Ad. From *T.* (*S.*) *vitiligineus*, Mke., from which it differs in these respects, but in a less degree, it may further be distinguished by its greater depression, its smaller mouth, its weaker sculpture, its greater glossiness, its feebler iridescence, and its minute umbilicus.

21. TROCHUS (SOLARIELLA) ALBUGO, n. sp.

Apr. 17–18, 1874. Port Jackson, Sydney. 2–10 fms.

Shell.—Small, conoidal, with a tumid conical base, bluntly bicarinate, umbilicate, with a resinous lustre, brown, flecked with crimson and white. *Sculpture.* Very many irregular oblique faint lines of growth, with a few remote rounded spirals, which are very weak above, stronger on the base, and of which two at the periphery form a feeble double carina. *Colour.* A pale transparent resinous brown, flecked below the sutures and at the periphery with alternate spots of white and crimson; the latter colour runs in minute zigzag streaks down the shell; there are also, both above and on the base, a few delicate spirals of alternate crimson and white specks. *Spire* rather low, with curved contours and a blunt round apex. *Whorls* 5, rounded and sloping above, flat at the periphery, and tumid on the base. *Suture* linear and very slightly depressed. *Mouth* rather large, round. *Outer lip* thin. *Inner lip* thin, hollowed out backwards, and bending somewhat across the umbilicus. *Umbilicus* a broad shallow funnel, contracting to a small deep hole. H. 0·125. B. 0·2, least 0·15. Penultimate whorl 0·05. Mouth (in consequence of obliquity), height 0·125, breadth 0·1.

This species differs from *T. lamprus*, W., in being higher, with a larger mouth, and very unlike in colour and in sculpture. It is perhaps most like *T.* (*S.*) *vernicosus*, Gould, but that is flatter and has a much wider umbilicus.

ECHINELLA, *Swainson.*

ECHINELLA (?) TECTIFORMIS, n. sp.

St. 235. June 4, 1875. Lat. 34° 7′ N., long. 138° E. Japan. Bottom temp. 38°·1 F. 565 fms. Mud.

Shell.—High, conical, tectiform, carinated, umbilicated, with a flattish depressedly conical base. *Sculpture.* There are many sinuous, rather remote, longitudinal puckerings, minute below the suture; then evanescent, but on the whole lower half of the whorls rising into rarer, narrow, sharply rounded riblets, separated by flat intervals of fully twice their width; on the carina they rise into sharpish little longitudinal tubercles; below this they rapidly and almost wholly disappear, showing on the base only as slight undulations marking the very curved lines of growth. Besides these there are minute round threads which fret the whole surface. *Spirals.* The base of each whorl is thrown out into a narrow sharp expressed carina, which is rendered more prominent both by the longitudinal tubercles and by the imbrication of the whorls, which project markedly above the suture; the whole surface of the shell is, moreover, covered with fine unequal rounded threads, which are coarser in proportion to the development of the longitudinal puckerings, and which are crisply crimped by the finer longitudinals. On the base a slight swelling runs round near the outer edge. *Colour* a dead, faintly yellowish, chalky white, but which is not altogether without polish. *Spire* very high and narrow. *Apex* broken. *Whorls.* Only 4 remain, of very regular increase; flatly and very straightly sloping down from the deep suture to the carina, below which they are sharply constricted; each whorl is thus imbricated over the one which succeeds it. *Suture* squarely angulated and deeply impressed. *Mouth* squarely rounded, rather small. *Outer lip* thin. *Pillar-lip* broadly reflected over the umbilicus. *Umbilicus* small but deep, with a narrow swollen edge. H. 0·9 (?). B. 0·65, least 0·58. Penultimate whorl 0·2. Mouth, height 0·25, breadth 0·25.

The only specimen of this species is badly broken, so that the measurements, that of height in particular, are somewhat imaginary. It is so remarkable a form, however, that it is well worth preservation and description. In the absence of apex, operculum, and animal, its generic place is somewhat doubtful. The texture of the shell rather suggests a *Solarium*, but its extraordinarily high and narrow form, its almost poriform umbilicus, and the character of its sculpture point more to *Echinella*. In shape it resembles *Helix Schrammi*, Fischer (Journ. de Conch. 1858, p. 184, pl. vii. f. 8), more than any thing else I know.

Lacuna, *Turton.*

1. *L. picta,* n. sp. 2. *L.* (*Hela*) *margaritifera,* n. sp.

1. Lacuna picta, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S. to 9° 10′ S., long. 34° 49′ W. to 34° 53′ W. 350 fms. Mud.

Shell.—Pointedly and squarely subglobose, small, thin, translucent, dull yellowish with crimson stains. *Sculpture.* The lines of growth are few, faint, and irregular. *Spirals.* The whole surface is covered with minute, close-set, scarcely raised, rounded threads, about 0·002 in. apart. About $\frac{1}{5}$ of the whorl's breadth below the suture there is a slight angulation, and a still fainter angulation surrounds the base. *Colour* yellowish, with maroon stains markedly on two zones, one below the sutural angulation, the other above that of the base, on both of which there are arrow-headed, irregularlydefined blotches, with small irregular zigzags over the whole surface. *Epidermis.* There are traces of an excessively thin horny epidermis. *Spire* rather high. *Apex* small, rounded, and a little flattened and compressed. *Whorls* 5, convex, flattened in the middle, which gives a certain squareness of outline; towards the upper part there is a slight angulation, between which and the suture there is a slight constriction. The mouth is $\frac{2}{3}$ of the whole length. *Suture* distinct and slightly impressed. *Mouth* very perpendicular, oval, bluntly pointed above, and a little squarish from the straightness of the pillar and of the outer lip. The *outer lip* is thin. The *pillar* is narrow, bends a little to the left, is somewhat straight, but is a little excavated, with a slight angulation at its junction with the body and also in front. *Inner lip* crosses the body in a thin glaze; down the pillar it is flat, patulous and sharp-edged, behind it lies the narrow shallow groove-like *umbilicus*, the exterior edge of which, as in the genus generally, is continuous with the outer lip. H. 0·15. B. 0·12, least 0·1. Penultimate whorl 0·04. Mouth, height 0·1, breadth 0·075.

This species a good deal resembles the young of *L. crassior*, Mont., but is smaller, more globose, and much less angulated on the base. It is very like the *L. fragilis*, Mke., but that species is much more membranaceous, has the pillar more curved, and the umbilical groove is wider and larger; the coloration, too, is quite unlike. Dr. J. Gwyn Jeffreys claims this species for his genus *Hela*; or *Cithna*, as he now proposes to call it, *Hela* having

been already used by Münster, in 1830, for a genus of Crustacea —a change this in which it is to be hoped he will not persevere.

2. LACUNA (HELA) MARGARITIFERA, n. sp.

St. 246. July 2, 1875. 36° 10′ N., 178° E. Mid-Pacific, E. of Japan. Bottom temp. 35°·1 F. 2050 fms. Grey ooze.

Shell.—High, conical, strong, white, smooth, with a spiral of small beads just below the suture. *Sculpture.* There are many unequal not strong lines of growth. There are, on the upper part of each whorl, longitudinal puckerings stretching down from the infrasutural row of beads, strongest on the last. The surface is also finely scratched longitudinally. *Spirals* close, below the suture there is a fine beaded thread with a slight spiral furrow below it; there are many rounded, but very slightly raised spiral threads; the whole surface is also finely spirally fretted. *Colour* dead white, procellanous. *Epidermis.* None preserved. *Spire* high and conical. *Apex* broken. *Whorls* 3 (remaining), flatly convex; the last disproportionately long. *Suture* fine, but rather deeply impressed. *Mouth* oval, pointed above and at the end of the pillar, where it is also somewhat patulous, but the little expanded angle there is hardly enough to suggest a canal. *Outer lip* rather strong, very regularly curved from its junction with the body to the point of the pillar. *Pillar* very much curved. *Inner lip* carried across the body by a pretty strong callus, thin, sharp-edged, and projecting on the pillar. *Umbilicus* not large, but a well-marked and clearly defined furrow, whose exterior edge, however, is not, like that of *Lacuna*, continuous with the outer lip. H. 0·2. B. 0·13, least 0·1. Penultimate whorl 0·06. Mouth, length 0·1, breadth 0·07.

This is a much stronger shell than *L. tenella*, Jeffr., usually is; in form it is much higher in the spire, and narrower in proportion to breadth; the whorls are much more compressed, and the narrow sharply impressed suture is much less deep; the mouth is oval, not round, and the sculpture of the surface is very different from the hyaline gloss and texture of that other. It is unfortunate that the apex, which is so characteristic a feature in *L. tenella*, is broken in the 'Challenger' specimen.

FOSSARUS (*Adanson*), *Phil.*

FOSSARUS CEREUS, n. sp.

St. 184. Lat. 12° 8′ S., long. 145° 10′ E. East of Cape York, Australia. Aug. 29, 1874. Bottom temp. 36° F. 1400 fms. Grey ooze.

Shell.—Globosely conical, not thin, but waxily translucent, with a thin polished yellow epidermis. *Sculpture.* There are many oblique, fine, rather obsolete lines of growth. *Spirals.* There are several irregular, unequally parted, rounded and rather obsolete spiral threads, which are closer on the base. *Colour.* That of the shell is a translucent white; it is covered with a very thin, most persistent, hard, smooth, and horny *epidermis.* *Spire* somewhat turreted. *Apex* eroded. *Whorls* 3 (remaining), convex, but a little compressed towards the middle, round on the base, of very rapid increase, the mouth being fully two thirds of the whole length. *Suture* deep and irregular, but not canaliculated, except where eroded. *Mouth* oval, bluntly pointed above, glossy within. *Outer lip* thin and sharp, with a very regular curve, prominent on the base, and a little patulous towards the point of the pillar, where it is slightly, openly, and a little obliquely canaliculate. *Pillar* rather short, hollowed above, bending over a little to the left and terminating in a slight oblique tooth, which results from the slight canaliculation in which the mouth terminates, and which, as in *Rissoina,* is hollowed out of the point of the pillar. *Inner lip* porcellanous white, slightly reverted, and very closely appressed; a very thin glassy layer across the body unites the lips. *Umbilicus* none. H. 0·2. B. 0·19, least 0·15. Penultimate whorl 0·065. Mouth, height 0·17, breadth 0·1.

The generic place of this shell cannot be considered as satisfactorily determined. The whole aspect removes it from *Admete* and even more from *Rissoina,* which presents in a stronger form the basal sinus. The absence of an umbilicus removes it from *Isapis,* of which the *I. fenestrata,* Carp., has a swelling on the pillar-lip, strongly suggestive of this Australian species. On the whole the general appearance of the shell is liker that of a *Fossarus* than any thing else; and though Philippi's generic diagnosis of *Fossarus* (Arch. f. Naturg. vii. 1, 42) gives an edentulate inner lip as a characteristic feature, yet in *Fossarus Adansoni,* which is the original type of the genus, there is a blunt tooth and a slight sinus or groove on the front of the pillar. As to the large umbilicus which is constantly attributed to the *F. Adansoni,* it is often a mere chink, and occasionally it is quite absent. Of an epidermis, I confess I have never seen a trace. In the absence of animal and operculum it is better to avoid the creation of a new genus, though this may probably be necessary in the end; and I am glad in this difficult classification to have the support of Dr. J. Gwyn Jeffreys.

Jeffreysia, *Alder*.

Jeffreysia edwardiensis, n. sp.

St. 145*a*. Dec. 27, 1873. Lat. 46° 41′ S., long. 38° 10′ E. Prince Edward Island, between Cape of Good Hope and Kerguelen. 50 to 150 fms.

Shell.—Tumidly conical, flattish on the base, thin, glassy. *Sculpture.* The whole glossy surface is covered with extremely fine lines of growth, and with still fainter and more minute spirals, which are only vaguely discernible under the microscope and in very favourable light. *Colour* whitish, hyaline. *Spire* conical. *Apex* bluntish, and a little obliquely rounded. *Whorls* $4\frac{1}{2}$, tumidly convex or rounded, of regular increase until the last, which is somewhat disproportionately swollen. *Suture* rather shallow and open. *Mouth* perpendicular, oval, rather large. *Outer lip* sharp and thin, with a slight sinus at its junction with the body; incurved above, slightly flattened in the middle, advancing below, patulous and longitudinally prominent, but slightly sinuated towards the point of the pillar. *Inner lip* just connected with the outer by a film across the body, closely and shortly bent back on the umbilicus, and sharp on the edge of the pillar. *Pillar* straight, angulately springing from the body-whorl, bending a little to the left. *Umbilicus* a minute chink, almost covered by the inner lip. H. 0·075. B. 0·048, least 0·04. Penultimate whorl 0·017. Mouth, length 0·037, breadth 0·028.

The general aspect of this shell resembles that of *Jeffreysia*, but the inner lip by no means presents so continuous a peristome as any of our British species of the genus, and the junction of the pillar to the body is quite distinctly angulated, which is not the case in any *Jeffreysia* known to me. If assigned to this genus, therefore, it is rather because none else lies nearer, and in the absence of the animal and of the operculum, a new genus would be absurd here.

Cerithium (*Adanson*), *Brug.*

1. *C.* (*Triforis*) *levukense*, n. sp.
2. *C.* (*T.*) *bigemma*, n. sp.
3. *C.* (*T.*) *hebes*, n. sp.
4. *C.* (*T.*) *inflatum*, n. sp.
5. *C. matukense*, n. sp.
6. *C. phoxum*, n. sp.
7. *C.* (*Bittium*) *lissum*, n. sp.
8. *C.* (*B.*) *amblyterum*, n. sp.
9. *C.* (*B.*) *mamillanum*, n. sp.
10. *C.* (*B.*) *amboynense*, n. sp.
11. *C.* (*B.*) *pigrum*, n. sp.
12. *C.* (*B.*) *luscinæ*, n. sp.
13. *C.* (*B.*) *philomelæ*, n. sp.
14. *C.* (*B.*) *gemmatum*, n. sp.
15. *C.* (*B.*) *pupiforme*, n. sp.
16. *C.* (*B.*) *enode*, n. sp.
17. *C.* (*B.*) *oosimense*, n. sp.
18. *C.* (*B.*) *cylindricum*, n. sp.
19. *C.* (*B.*) *abruptum*, n. sp.
20. *C.* (*B.*) *delicatum*, n. sp.
21. *C.* (*B.*) *aëdonium*, n. sp.

1. Cerithium (Triforis) levukense, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Sinistral, sharply conical, with a narrow and produced base, solid, yellowish white, glossy. *Sculpture.* Longitudinals—there are (on the last whorl) about twenty longitudinal rows of round tubercles, which rows form a small rib across the whorl, and are more or less continuous up the spire; these continue on the base as strongly as on the upper part of the whorls. These rows are parted by shallow rounded depressions. Spirals—the longitudinal rows are cut by narrow little rounded grooves, whose intersection with them forms the tubercles. On the upper whorls there is only one such spiral groove, so that there are only two tubercled spirals, but the groove gradually widens, and there appears in the bottom of it a minute additional spiral, which finally becomes as large as the other two; on the base are 3 equally divided tubercled spiral threads, of which the inmost is the smallest, and it ceases at the siphonal tube. The *apex* consists of 6 small rather elongated narrow whorls, of which the first $1\frac{1}{2}$ have about ten rows of minute tubercles faintly connected by spirals; the next $4\frac{1}{2}$ whorls are crossed by about 24 longitudinal sharp little ribs, rising into points at the carina, which is a continuous spiral thread. This carina on the first of these whorls is near the base, but later it rises so as to encircle the upper part of the whorl. The minute spiral rows of tubercles, which alone appear on the first whorl and half, cover the whole surface (both ribs and interstices) on the later apical whorls. The regular sculpture does not begin abruptly and at once, but a tongue of this new sculpture breaks across the top of the whorl, while the lower part retains the earlier ornamentation.

Colour. The apical whorls are amber, the rest of the shell yellowish white, with a narrow amber-coloured thread within the contraction of the base of each whorl; this spiral thread is not continuous, being interrupted by each of the longitudinal rows of tubercles. *Spire* high, sharply conical, with a very slight convexity in its lines of profile, which are not perfectly alike. *Apex* a narrow and perfect cone, ending in a small rounded point. *Whorls* 17, of very regular increase, flat on the side; the whole last whorl is contracted and a little elongated; the base is narrow and flat. *Suture* sharply impressed, and broader than the spiral grooves, being marginated on its upperside by a minute flat surface, which runs round the base of the superior whorl. *Mouth* almost more than perpendicular, square, with a largish auricle at

its upper corner, and a small and very transverse rift at the pillar. *Outer lip* sharp, thin, straight, perpendicular, angulated at the basal corner, flat across the base, turned in towards the mouth and pinched in at the pillar, where it joins the pillar-lip, closing in the side of the small siphonal canal, whose edge is sharp and straight, or a very little contracted all round. *Pillar* straight in front, then very much bent back, so that its posterior line almost stands on the edge of the base. *Pillar-lip* expanded but abruptly defined on the base, blunt but projecting on the pillar, where it is covered by and cemented to the outer lip. H. 0·22. B. 0·07, least 0·06. Penultimate whorl 0·032. Mouth, length 0·037, breadth 0·035.

This beautiful little species is very like in general aspect to *C. perversum*, L.; but, apart from other obvious differences, the sculpture of the apex is quite distinct. In that species the extreme apex has about seven spiral scatches, parted by roughened threads, and the following whorls are beset with much closer-set and more numerous riblets, and they have two close-set spirals at the carina. The whole of this sculptured apex (in *C. perversum*) is stumpier, and the whorls are not so angulated, and the extreme point is blunter.

T. Hindsii, Desh. (Bourbon Moll. p. 99), is very near, but is less contracted in front towards the base, has not there near the mouth four rows of pearls, has the pearls white on a brown ground, has not the single amber thread, and is a little narrower in proportion.

2. Cerithium (Triforis) bigemma, n. sp.

St. 24. Mar. 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. St. Thomas, N. of Culebra Island, Danish West Indies. 390 fms. Coral-mud.

Shell.—Sharply conical, high and narrow, solid, opaque, brilliant, yellowish white. *Sculpture.* Longitudinals—the whorls are crossed by rows of tubercles with broad and rounded hollows between; of these longitudinal rows there are 17 to 18 on the last, and about 14 on a great many of the preceding whorls; besides these the surface is sharply, distinctly, and pretty closely scored by minute lines of growth. Spirals—a prominent spiral band encircles the whorls formed by two rows of rounded tubercles, which in each row are connected by a spiral thread; of these threads the lower is rather the larger, sharper, and more prominent. The distance between these threads is very nearly

the same as that between the longitudinal rows, so that each group of four adjoining tubercles forms nearly a rhomb. Round the upper part of each whorl is an impressed flat surface, in which, very near the suture, lies another smaller spiral, which becomes minutely tubercled where it crosses the longitudinal rows. At the bottom of each whorl is a very minute spiral thread, which forms a pouting edge to the suture. Besides these the surface is faintly reticulated by microscopic spirals crossing the longitudinal lines of growth. This reticulation is best seen on the flat and glossy base, which is unbroken except by a small sharp spiral, about 0·012 in. within the edge. *Colour* yellowish white, pure white on the upper part of the spire; round the base of each whorl is a suffused pale tint of brown, which is more or less the colour of the base of the shell; the point of the pillar is white. *Spire* high, narrow, and conical, slightly slewed to the left; so that while the left slope is straight, almost concave, the right slope is just perceptibly convex. *Whorls* probably 22, but of these the 3 or 4 apical ones are broken off; they are of very slow increase, flat, constricted on their upper part, flatly prominent in the middle, and contracted at the lower part; the base of the shell is flatly conical. *Suture* strongly defined by the depression in which it lies, but itself linear and projecting, being minutely marginated both above and below. *Mouth* squarely oval, pointed above and at the front of the pillar by the canal, which is small. *Outer lip* broken. *Pillar* short, small, straight, scarcely excavated or twisted, at the point sharp and slightly advancing outwards. *Inner lip.* A very thin layer of glaze is carried across the body, and turns round the pillar in a few microscopic lines, by which alone it can be traced. H. 0·6. B. 0·12. Penultimate whorl 0·072. Mouth, length 0·08, breadth 0·06.

This has a good deal the proportions of *C. metula*, Lov., with a narrower base. It slightly resembles the *Triforis Pfeifferi*, Crosse, and (apparently, for the B. M. tablet has more than one species on it) the *T. scitula*, A. Ad., both from S. Australia; but these have only one series of gemmules, the upper row being very much smaller, and in both the whole shell is very much smaller and slenderer. *T. gigas*, Hinds, is a much thinner and less strongly tubercled and sutured shell. *T. angustissima*, Desh. (Moll. de Bourbon), is larger, broader in proportion, has the lower (in his description "supérieure," as he reverses the shell) row of tubercles larger, and lacks the infrasutural flat constriction with its small and finely tubercled spiral.

3. Cerithium (Triforis) hebes, n. sp.

St. 135. Oct. 18, 1873. Nightingale Island, Tristão da Cunha Islands, S. Atlantic. 100–150 fms. Rock; shells.

Shell.—Cylindrically conical, blunt, uncontracted towards the base, strong, translucent, hardly glossy. *Sculpture.* Longitudinals —on the last whorl there are about 20 longitudinal rows of rounded tubercles, parted by depressions of much the same breadth and form as themselves; they run more or less continuously and straight up the spire from whorl to whorl. There are indistinct lines of growth. Spirals—on each whorl the tubercles are arranged in three spiral rows, parted by rather deep but narrow squarish furrows. The highest row is rather smaller and less prominent than the others. The base of each whorl is sharply but not deeply constricted; the edge of this constriction appears on the margin of the base as a rounded thread, defined by a slight furrow, which, with the exception of microscopic radiating lines of growth, is the only ornament of the flat and very slightly conical base. *Colour* pure somewhat translucent white. *Spire* high and conical, but contracting very little, and hence more cylindrical than usual. *Apex* very blunt, but almost mucronated; this arises from the three embryonic whorls, which are smooth, being formed of two tumid threads, of which the lower is the larger, but the upper is at first the more prominent, and at its origin stands up minute, round, and prominent, like a small eccentric blunt spike, reminding one of the mucronated mamillary plug of some of the *Cæcums.* It is not a plug, however, but the true embryonic form. This embryonic shell is smooth and glossy, but has some faint trace of spiral sculpture. *Whorls* 12, of very gradual increase, flat on the sides, constricted below, flat and hardly conical on the base. *Suture* well defined by the contraction of the whorl above it, and by a minute thread on which it projects. *Mouth* angulately oval, with a small straight canal in front. *Outer lip* broken. *Pillar* perpendicular, straight, short, narrow, pointed. *Inner lip* a thickish porcellanous glaze. H. 0·24. B. 0·06. Penultimate whorl 0·03. Mouth, length 0·032, breadth 0·02.

This species has some resemblance to *T. suturalis*, Ad. & Rve., but is easily distinguished from that by its blunt apex and the less sunken suture.

4. Cerithium (Triforis) inflatum, n. sp.

St. 24. Mar. 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W.

St. Thomas, N. of Culebra Island, Danish West Indies. 390 fms. Mud.

Shell.—Small, narrow, conical, with a blunt inflated apex, solid, opaque, glossy. *Sculpture.* Longitudinals—there are on the last whorl 16 rows of small rounded but not blunt tubercles, which more or less continuously run obliquely down the spire in lines from right to left; the hollows which part them are in form much like themselves; there are also faint microscopic scratches on the lines of growth. Spirals—on each whorl the tubercles are arranged in two spiral rows, in which the tubercles have their sharp tips tilted up the spire, and they are parted by a triangular-shaped furrow, narrower than the spirals of tubercles. Below the under row of tubercles is a broader furrow, in the bottom of which runs the suture on the spireward face of a fine rounded thread occupying the extreme upper edge of the subjacent whorl. This thread is undulated rather than tubercled where it crosses the longitudinal rows; on the spireward side this thread is defined by a minute deep square-bottomed trench, while on the basal side it lies close in to the foot of the upper spiral row of tubercles. Round the edge of the base is a slight sharp narrow keel, which the succeeding whorl as it grows buries in the spiral thread mentioned above. At 0·004 from the edge, and there forming a ledge, the whole centre of the base is slightly projected: with this exception, the flat and scarcely conical base has no ornamentation beyond the radiating lines of growth and the microscopic spirals, which, though visible on the rest of the shell, are, as usual, more distinct on the base. *Colour* dull translucent white. *Spire* high, narrow, and conical. *Apex* blunt and inflated. The two embryonic whorls are larger, but otherwise very much like those of *C. metula*, Lov., being turban-shaped and projecting beyond the succeeding whorls; they are glossy and quite smooth but for some very faint microscopic longitudinal and spiral lines. *Whorls* 13, of very gradual increase, flat on the sides; the base, too, is flat, and very little conical. *Suture* linear, almost hidden by the overlap of the subjacent whorl. *Mouth* very small and square, with a minute, round, very short canal in front, whose edges are reverted all round. *Outer lip* broken. *Pillar* very small, extremely short, straight, but reverted at the point. *Inner lip* not fully formed. H. 0·2. B. 0·06. Penultimate whorl 0·02. Mouth, length 0·028, breadth 0·025.

This species, which in shape resembles *T. suturalis*, Ad. & Rve., may be easily distinguished from that species by the absence of

the deep suture and by the inflated apex. From *C.* (*T.*) *hebes*, W., its sculpture and its apex distinguish it at once.

5. Cerithium matukense, n. sp.

St. 173. July 24, 1874. Lat. 19° 9′ 32″–35″ S., long. 179° 41′ 50″–55″ E. 310–315 fms. Coral.

Shell.—A tall, narrow, sharply-pointed cone, somewhat tumid in the last whorl, with little sculpture, but with largish white varices, and beautiful glossy brown spiral threads, speckled with white on a dull translucent white ground. *Sculpture.* Longitudinals—the upper whorls are thickly set with narrow, close, curved, tubercled ribs, which run with a slight twist almost continuously from whorl to whorl; irregularly, but on nearly each whorl, one of these ribs swells and broadens as a white varix. On the later whorls the ribs are much less marked and the tubercles crowd closely together on the spiral threads; the varices, too, become larger, and appear at the distance of $1\frac{1}{2}$ whorl; the surface is also thickly set with fine sharpish hair-like lines of growth. Spirals—Besides one in the suture concealed by the succeeding whorl, there are on the small apical whorls 3, but on the last 13 or 14 whorls there are 4 narrow well-defined rounded glossy spiral threads; on the last whorl, in its latter half, one or two more narrower threads appear on the upperside of the whorl; on the base they are narrower and set more closely, and four or five delicate ones ornament the pillar. On the last whorl especially the upper spirals are studded with close-set small round tubercles. The interstices are about three times as broad as the threads themselves, and are delicately fretted with very fine spiral lines. *Colour* a translucent white, dead towards the apex, with some irregular brownish stains on the spire, dead-white varices, and brilliant brown spiral threads spotted with white tubercles. *Spire* tall, conical, and a little bent. *Apex* sharp but rounded. *Whorls* 20, of very slow and regular increase, scarcely convex, but the last is a little tumid, flattened on the base, but not at all angulated, and bisected by an exceptionally large varix. *Suture* linear, but with a very slight impression. *Mouth* nearly semicircular, from the great sweep of the outer lip, and the very slight relative concavity of the whole inner lip from the upper corner of the mouth to the point of the pillar; porcellanous within. At its upper angle there is a narrow little corner formed by a slight contraction of the lip towards the body, and by the elevation of the second basal thread into a tooth by a porcellanous thickening at this

point. *Outer lip* ascends slightly on the body-whorl, towards which at the same time it is a very little pinched in. From this point to the edge of the canal it forms a very equable curve; slightly retreating at first so as almost to form a shallow open sinus, it is thrown out into a wing-like projecting expansion in the middle. It is patulous, reverted, thin on the edge, but thickened within by a glossy porcellanous callus, stained dark brown at the ends of the spiral threads. The short anterior canal bends over towards the pillar, is well defined, round, with the oral lips a little contracted and its front margin a good deal reverted. The *pillar* is short, straight, narrow, at the point sharp and bent to the left, with a narrow and twisted edge; in colour porcellanous white. *Inner lip* is glossy, rising into a tooth on the first intraoral thread, spread out on the body, with a slightly thickened and well-defined edge on the pillar. H. 1·6. B. 0·47, least 0·34. Penultimate whorl 0·23. Mouth, length 0·32, breadth 0·27.

This species in form and colour is not unlike *Cerithium longicaudatum*, Ad. & Rve., or *C. attenuatum*, Phil., but in details of whorls and of sculpture it is totally different.

6. Cerithium phoxum, n. sp. (*φοξός*, tapering.)

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Sharply conical, on the base contracted and a little obliquely flattened, longitudinally ribbed with spiral tubercled threads, of a certain waxy whiteness tinged with yellow and ruddy brown. *Sculpture.* Longitudinals—there are from ten to eleven straight but oblique riblets on each whorl; on the earlier whorls they are pretty continuous, with a sinistral twist round the spire, but on the later whorls they become less regular. Besides these there are fine scratch-like lines of growth. Spirals—on the upper whorls there are four, on the later five, which, as they cross the riblets, rise into tubercles. They are parted by intervals of two to three times their width, and in these intervals two or three narrower but similar threads appear, as they do also on the base, where there are two stronger circumbasal threads and a multitude of finer hair-like spirals, which extend to the point of the pillar. Besides these the whole surface is covered with finely fretted microscopic spirals. *Colour* a delicate waxy straw-colour, with stains of a brownish flesh tinge. *Spire* very slightly scalar, straight, and very sharply conical. *Apex* fine. *Whorls* 14,

of slow increase and straight outline, with about one varix on each. *Suture* a very little impressed at the base of each whorl. *Mouth* oval, with a sharp angulation at the canal and at the upper corner, where the lip is sinuated and pinched in against the body-whorl, and where the corner is further narrowed into a little canal by the strong tooth which rises nearly on the interior basal thread. *Outer lip* sharp, fluted on the edge, thickened by an external varix; ascending a little at its junction with the body-whorl, it retreats so as to form a slight sinus; it sweeps round with a very equable curve, advancing about the middle into a patulous wing-like projection; across the base it is flat, advancing, but scarcely patulous. The anterior canal is rather narrow and deep, short, bent back, and with its front margin reverted all round except on the pillar. *Pillar* short, angulated, and slightly twisted in front where it bends to the left, sharp-pointed. *Inner lip* thickened, and forming a ledge along its whole length. H. 0·8. B. 0·27, least 0·22. Penultimate whorl 0·12. Mouth, length 0·2, breadth 0·17.

7. CERITHIUM (BITTIUM) LISSUM, n. sp. (*λισσός*, smooth.)

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Conical, rather stumpy, a little contracted and drawn out on the base, longitudinally ribbed, smoothed, of a brownish-white colour. *Sculpture.* Longitudinals—towards the apex there are on each whorl about twelve small, rounded, rather hunchy, straight and regular ribs, parted by hollows broader than the ribs; these very soon become less regular, and, though larger, are less so relatively to the size of the whorls and to the breadth of the hollows between them. On the penultimate whorl they become nodose, especially on the lower part of the whorl, and on the last whorl they are almost entirely replaced by unconnected rows of tubercles. The surface is very faintly scratched with lines of growth. In the middle of the last whorl there is a pretty strong white varix, broad above and projecting below. Spirals—there are many (on penultimate whorl about 20) irregular, unequal and unequally-parted scratches, three or four of which are markedly larger than the rest. Raised between these lie minute hair-like lines, with here and there a flat thread, which, in crossing the ribs, rise, at the top and especially near the bottom of the whorls, into rounded tubercles. On the last whorl there are four rows of these tubercles—one just below the suture, where they are

broad and flat; the second small and indefinite; the third at the periphery, where, transversely long, the tubercles are sharp and small; the fourth row is within the base, and there they are very small. The pillar is feebly scored with many remote very small threads. The surface is otherwise smooth and rather glossy. *Colour* dead white, with minute longitudinal lines and spots of faint ruddy brown, with suffused stains of fainter brown; on the penultimate whorl there are five, on the last ten very fine spiral lines of the same colour. *Spire* sharply but slightly convexly and a very little gibbously conical. *Apex* sharp. *Whorls* about 14, of regular increase, flat; the last is contracted and drawn out and slightly bent from the axis of the shell, while the base is a little pinched in. *Suture* very faint. *Mouth* oval, but pointed at the canal and at the upper corner, where it is narrowed by a slight contraction of the lip and by the basal tooth; porcellanous and glossy within. *Outer lip* ascends markedly on the body-whorl, sinuated, contracted, and a little turned in above, expanded, patulous, and wing-shaped in the middle, flat and slightly turned in on the base. It is on the edge rounded, thin, irregularly channelled, with an external, narrow, projecting varix. The canal is longish, narrow, and very much cut off obliquely backwards. *Pillar* is short and narrow though strong, but rises from an elongated base; it bends to the left, and has a long fine edge on the margin of the canal. *Inner lip*. Above and at the basal tooth it is thick and abrupt on the edge, but below this thin though defined; it is somewhat thicker along the canal. H. 1. B. 0·36, least 0·29. Penultimate whorl 0·17. Mouth, length 0·28, breadth 0·19.

8. Cerithium (Bittium) amblyterum, n. sp. (ἀμβλύτερος, rather blunt.)

St. 75. July 2, 1873. Lat. 38° 38′ N., long. 28° 28′ 30″ W. Fayal, Azores. 500 fms. Sand.

Shell.—In general aspect very much like *C. metula*, Lov., but narrower, and having a sharper apex, and in texture and ornamentation recalling an *Odostomia* of the *Chemnitzia* group. *Sculpture*. Longitudinals—there are on the last whorl twenty-one small longitudinal ribs, which run more or less continuously straight up the spire; they are curved so as to be posteriorly convex, and each bears two tubercles—one, the smaller, near the top, the other near the bottom of the whorl; their interstices are shallow, flat, and narrow. There are, besides these, faint lines

of growth, which, on the base, are curvedly radiating and strong. Spirals—there is a spiral thread near the top of each whorl, connecting the upper series of tubercles, and the adjacent tubercles at the lower ends of the ribs are confluent, forming a continuous spiral; round the edge of the base is a fine round carinal thread; of microscopic spirals there seems to be no trace. *Colour* translucent white. *Spire* high, narrow, and conical. *Apex* small, glossy, roundly pointed and oblique, the extreme point rising slightly on one side. The embryonic whorls are two, slightly oblique, convex and perfectly smooth, but for some very faint spiral scratches. After these faint and sparse riblets begin to appear, and only after two more whorls do these reach distinctness. The second, though narrower, is higher than the third. *Whorls* 12, of very gradual increase, flat on the sides, slightly carinated by the projection of the lower thread of tubercles, a little contracted into the suture, on the base scarcely convex but conical. *Suture* linear and very minute. *Mouth* squarish, with a largish oblique opening into the canal, which is semicircular, a little oblique, and with very shortly reverted edge. *Outer lip* thin, straight, but strongly angled at the corner of the base. *Pillar* very short, perpendicular, rather broad, rather sharp-edged at the point, where it is obliquely truncate and tilted to one side. *Inner lip* a very thin layer of glaze. H. 0·25. B. 0·065. Penultimate whorl 0·03. Mouth, length 0·033, breadth 0·027.

While the general form of this species resembles *C. metula*, Lov., the sculpture is very distinct, and the apex, though blunt, is much finer and sharper, and not inflated as in that species.

9. Cerithium (Bittium) mamillanum, n. sp.

St. 120. Sept. 9, 1873. Lat. 8° 37′ S., long. 34° 28′ W. Pernambuco. 675 fms. Mud.

Shell.—In general aspect very much like *C. metula*, Lov., but narrower, and having a still blunter and more swollen apex. *Sculpture.* Longitudinals—on the last whorl there are twenty-one small, narrow, longitudinal ribs, which are curved so as to be posteriorly convex; they appear faintly on the outer circumference of the base; the line of these from whorl to whorl runs very straight up the spire. The whorls are also microscopically striate in the lines of growth. Spirals—near the suture a spiral thread encircles the top of the whorls, and rises into minute tubercles where it crosses the ribs; near the foot of the whorls is a strong

carination, and here each longitudinal rib projects strongly into a rounded, narrow, longitudinal tubercle; the base is encircled by a small sharp thread, which is undulated but not tubercled by the longitudinal ribs. *Colour* translucent white, more ivory than porcellanous. *Spire* high, narrow, and conical. *Apex* blunt, inflated, and projecting beyond the contour-lines of the spire, as if the two embryonic whorls had been squeezed down and spread out in the operation. They are glossy and quite smooth, but with a trace of spiral arrangement in the microscopic texture. Faint traces of the longitudinal ribs appear toward the end of the second whorl, and the spiral threads appear pretty strongly on the third. *Whorls* 12, of very gradual increase, slightly concave on the sides, and below the carina sharply contracted in toward the suture. *Suture* well marked by the contraction of the whorl above it and the slight angular prominence of the whorl below it. *Mouth* square and small. *Pillar* very short, perpendicular, broad, with a small, blunt, oblique but not reverted point. *Inner lip* a very thin layer of glaze. H. 0·22. B. 0·06. Penultimate whorl 0·025. Mouth, length 0·03, breadth 0·025.

The sculpture in this species resembles a good deal *C. amblyterum*, W., as they both do *C. metula*, Lov.; but the details of the sculpture are quite different, and the peculiar form of the apex distinguishes it easily from both. The only specimen of this shell was unfortunately broken before it was figured.

10. Cerithium (Bittium) amboynense, n. sp.

October 6, 1874. Amboyna. 15–20 fms.

Shell.—Small, narrow, conical, with convex outline, a narrow, contracted and bluntly conical base, solid, opaque, dull, light brown. *Sculpture.* Longitudinals—there are on the last whorl about 20 broad, shallow depressions, parted by longitudinal rows of small tubercles, which, toward the mouth, tend to crowd out the depressions. These rows preserve no relation to each other in adjoining whorls. There is about the middle of the whorl a broad, feeble varix, which includes several of these rows of tubercles; there are besides many irregular lines of growth. Spirals—there are on the last three whorls four, and on all the preceding whorls three spiral threads, which are beset with small, low, round tubercles, which become smaller toward the mouth. Above the suture another very small spiral appears; it lies just within the contraction of the base, and has no tubercles. Within this,

on the base and close to it, is another and stronger spiral. A broad, shallow, but well-defined furrow lies within this, having a minute spiral in the bottom of it. The pillar rises within this furrow, encircled by a rather strongish spiral thread, and three more finer spirals twine round it. Only on the base is there the faintest trace of most minute microscopic spirals. *Colour* pale yellowish brown, quite uniform throughout. *Spire* high and narrow, with convex contour-lines, which are strongly impressed at the suture. In the upper part of the spire the whorls are a little scalar. *Apex* broken. *Whorls* 9, flat, of very gradual increase. *Suture* impressed. *Mouth* square. *Outer lip* broken. *Pillar* straight, short, and broad. *Inner lip* formed by a thick layer of glaze, which presents a narrow edge on the pillar. H. 0·14. B. 0·05. Penultimate whorl 0·025. Mouth, length 0·03, breadth 0·02.

This species very much resembles *C. reticulatum*, Da Cos., but there is appreciable difference in its contour-lines, which are much more curved, and the upper whorls are scalar, while in the young of that species, with the same number of whorls, the contour-lines are straight and the outline perfectly conical. In this, too, the base is more contracted and hollower than in that. The apex is unfortunately broken; but the basal part of the embryonic shell is broader, less oblique, and has not the characteristic fine spiral threads which encircle the base of the second and third whorls in that species.

11. Cerithium (Bittium) pigrum, n. sp.

St. 135. October 18, 1873. Nightingale Island, Tristão da Cunha Islands. 100–150 fms.

Shell.—Tall, narrow, conical, with convex outlines, blunt, flat on the base, strong, opaque white. *Sculpture.* Longitudinals—there are on the last whorl twenty-one flattish, rounded, narrow ribs, parted by depressions of about the same form and size; the surface is also very faintly microscopically striate. Spirals—on all the whorls, except the first two, there are three fine narrow spiral threads, which rise into feeble tubercles where they cross the longitudinals. The first and second are a little closer together than the second and third, which are separated by a flat space of about twice the breadth of the spirals. Below the lowest spiral there is a rather abruptly sloping but broadish contraction into the suture, close above which lies a plain, narrow, spiral thread, which on the last whorl forms the edge of the base, and is there

defined by an inferior minute spiral furrow. With the exception of this and of very faint microscopic spirals and lines of growth, the base is quite plain. *Colour* dead white. *Spire* high and narrow, with slightly convex outlines; the lowest tubercled spiral on each whorl slightly projects beyond the top of the whorl which follows. *Apex* blunt and smooth. *Whorls* 13, flat on the sides, narrowed upwards, constricted at the bottom above the suture. *Suture* minute, but well defined by the furrow and by the thread which lies in the bottom of it above the suture. *Mouth* square. *Outer lip* broken. *Pillar* short but rather narrow. *Inner lip* incomplete. H. 0·36. B. 0·095. Penultimate whorl 0·04. Mouth, length 0·08, breadth 0·05.

This, as regards its sculpture, also belongs to the *C. reticulatum* group.

12. Cerithium (Bittium) luscinıæ, n. sp.

St. 135. October 18, 1873. Nightingale Island, Tristão da Cunha Islands. 100–150 fms.

Shell.—Small, narrow, conical, blunt, with straight outlines, rounded but not contracted at the base, solid, translucent, glossy, white. *Sculpture.* Longitudinals—there are 17–18 longitudinal rows of coarse, flat, rounded tubercles, parted by furrows narrow and shallow; these lines run very straight up the spire. Spirals—on all but the first three whorls there are three equally-parted spiral threads, which rise into tubercles in crossing the longitudinals; of these three spirals the highest is the smallest and least prominent. The first whorl is smooth and glossy, with a few irregular wrinkles; the second is regularly and curvedly ribbed and furrowed longitudinally; on the third the general sculpture of the shell begins, but the highest spiral is absent, only its place is indicated by a broader infrasutural depression. The base has round its margin a sharp-edged thread, and close within this a very faint furrow. *Colour* translucent glossy white. *Spire* is high, narrow, and has straight outlines. The base of each whorl projects slightly beyond the top of that which succeeds it, and the suture is sunk in a well-marked furrow. *Apex* is abrupt and rounded, but the extreme point is obliquely prominent. *Whorls* 9, flat on the sides, narrowed upwards, and constricted at the bottom above the suture. *Suture* linear and very minute, but well marked by the furrow which lies above it. *Mouth* squarish. *Outer lip* incomplete. *Pillar* straight, short,

and strong. *Inner lip* unformed. H. 0·147. B. 0·06. Penultimate whorl 0·02. Mouth, length 0·03, breadth 0·028.

The sculpture of this species is after the fashion of the *C. reticulatum*, Da Costa, group, but the form of the shell, its details of sculpture, and the shape of the apex are very distinct. It is not quite full-grown, so that the form of the base is not entirely developed.

13. Cerithium (Bittium) philomelæ, n. sp.

St. 135. October 18, 1873. Nightingale Island, Tristão da Cunha Islands. 100–150 fms.

Shell.—Small, narrow, conical, blunt, outlines scarcely convex, rounded at the periphery into the blunt square base, solid, dead white, not glossy. *Sculpture.* Longitudinals—on the last whorl there are 21 rows of rather coarse round tubercles, parted by very narrow furrows; these lines run very straight up the spire. Spirals—on all but the first two whorls there are three very equal spiral threads, which rise into tubercles as they cross the longitudinals; these threads do not appear on the first two whorls; they are parted by shallow furrows. The base of the whorls is sharply but shallowly contracted, and in the bottom of the contraction, above the suture, lies a small spiral, which is undulated in crossing the longitudinals, and which, on the base, forms a weak, feebly-tubercled circumferential border. *Spire* is high, narrow, and has its outlines barely curved. *Apex* is blunt and rounded, with a very minute oblique projection. *Whorls* 8, just barely convex on the sides. *Suture* very minute and linear, but well marked by the furrow at the base of the whorls. *Mouth* squarish. *Outer lip* broken. *Pillar* straight, short, and broad. *Inner lip* a layer of glaze crossing the body and twining round the pillar. H. 0·128. B. 0·05. Penultimate whorl 0·025. Mouth, length 0·03, breadth 0·02.

This species, in its sculpture, belongs to the *C. reticulatum* group. Than *C. lusciniæ*, which it resembles, it is much smaller, more delicate in sculpture; the apex is less squeezed down than in that species.

14. Cerithium (Bittium) gemmatum, n. sp.

St. II. Jan. 13, 1873. Lat. 38° 10′ N., long. 9° 14′ W. Setubal. 470 fms. *Globigerina*-ooze.

Shell.—High, conical, not narrow for the genus, blunt, with

straight outlines, distinct suture, rounded base, tubercled, thin, translucent white. *Sculpture.* Longitudinals—the whorls are crossed by oblique, curved, and tubercled ribs, of which there are on the last whorl 17, on the preceding 14, and they diminish rapidly in number. They are quite obsolete near the mouth, and die out on the base; they are parted by open longitudinal furrows fully wider than themselves. The furrows and ribs run down the spire from whorl to whorl without a twist, but with a strong dextral obliquity. There are a very great many fine irregular and unequal lines of growth. Spirals—each whorl is carinated by two strongish rounded spiral threads, which rise into largish tubercles on the longitudinal ribs; the upper is rather the stronger and more prominent; near the mouth they both become feebler: the tubercles on the upper thread are smaller, while on the lower they disappear. These spirals are parted by a flat shallow furrow about twice as wide as themselves. Below the under spiral the whorls contract into the suture, above which is a very narrow flat thread, which on the base forms the strongish marginal border. Above the upper spiral the whorls also contract, and immediately below the suture there is a very small and feebly tubercled spiral. On the base, within the marginal thread, is another. The centre of the base is plain and a little impressed; round the base of the pillar are two fine threads, while a third, very minute, twists up the pillar. The whole surface is fretted with minute microscopic spiral scratches. *Colour* translucent white. *Spire* is high, and has straight outlines. *Apex,* which is blunt and perfectly rounded and glossy, has two whorls. *Whorls* 12, of regular increase, convex, being constricted above and below. *Suture* linear, but well marked. *Mouth* oval, scarcely pointed above, and with an open shallow canal in front, resembling that in *C. reticulatum.* *Outer lip* very thin, very slightly ascending where it joins the body, forming an equable, nearly semicircular curve to the edge of the canal. *Pillar* very short and little projecting, with a distinct twist; at the point small, rounded, and narrow-edged. *Inner lip* forming a continuous curve across the body and up the pillar; on the body it is a thin glaze, but its edge on the pillar is thicker and more defined. Height 0·31. B. 0·09. Penultimate whorl, height 0·04. Mouth, length 0·066, breadth 0·05.

15. Cerithium (Bittium) pupiforme, n. sp.

St. 186. Sept. 8, 1874. Lat. 10° 30′ S., long. 142° 18′ E. Wednesday Island, Cape York. Coral-sand. 8 fms.

Shell.—Small, narrow, conical, blunt, with convex outlines, contracted both toward the apex and the point of the base, reticulated, tubercled, solid, translucent, glossy, white. *Sculpture.* Longitudinals—there are on the last whorl about 25 rows of small, rounded, adjacent tubercles; they are parted by mere lines, and run pretty straight, but with a slight sinistral turn down the spire. On the upper part of the spire the rows are straight, but in the penultimate whorl, where the shell begins to contract toward the base, the rows have a slight concave and dextral curve. Spirals—on each whorl there are three equal spiral threads, which form the tubercles as they cross the longitudinal rows; they are parted by two narrow and shallow furrows; there is a strong deep sutural furrow. Besides these there are quite inconspicuous microscopic longitudinal and spiral lines on the surface. The very narrow base is encircled by a strong rounded prominent thread, within which a deep furrow surrounds the pillar. *Colour* translucent white. *Spire* high and narrow, with convex outlines. *Apex* extremely abruptly truncate, rounded. The smooth embryonic shell consists of one and a half whorls, and the tip of it scarcely rises into sight. *Whorls* 9, contracted upwards, flat on the sides. The base is extremely contracted; and as the contraction begins in the penultimate whorl, the form of the shell resembles the pupa of an insect. *Suture* only defined by the deep furrow in which it lies. *Mouth* oval, with a very small channel in front. *Outer lip* broken. *Pillar* very short, strong, but not broad; the point is in the only specimen slightly broken. L. 0·1. B. 0·037. Penultimate whorl 0·02.

In general form, but in that alone, this is very like some of the ill-thriven looking forms of *Cerithiopsis minima*, Brusina, but is obviously very different.

16. CERITHIUM (BITTIUM) ENODE, n. sp.

St. 120. Sept. 9, 1873. Lat. 8° 37′ S., long. 34° 18′ W. Off Pernambuco. 675 fms. Mud.

Shell.—Small, narrow, conical, apex blunt and mammillated, outlines straight, square on the base, finely ribbed, but not reticulated nor tubercled, thin, white. *Sculpture.* Longitudinals—there are on each whorl about 26 small, narrow, sharp, curved distant ribs, which run continuously from whorl to whorl, and very straight down the spire. The ribs are about 0·001 in. wide, and the interstices five to six times as much; toward the apex they become

more crowded. In the interstices a feebler riblet is occasionally intercalated. They die out on the base with a strong, posteriorly convex curve. Spirals—near but not just at the suture the top of each whorl projects in a sharp minute carina, defined by a spiral thread, which forms a small knot in crossing each riblet; about one third down the whorl a very fine sharp thread runs round the shell, rising over, but scarcely forming knots on the riblets. Another one third down a very faint thread appears. The margin of the base is defined by a sharp, minute, knotted, carinal thread, the edge of which may just be traced at the bottom of each whorl, just above the suture, all the way up the spire. The base is plain but for a very faint submarginal thread. The apex is smooth and glossy, with nothing but microscopic evanescent superficial spirals. Over the whole surface of the shell there is a microscopic reticulation of faint, pretty equal, longitudinal and spiral scratches. *Colour* ivory-white. *Spire* high, narrow, with perfectly straight conical outlines. *Apex* truncate, and then finished with a slightly depressed mammillate, glossy, pure white tip, consisting of a whorl and a half, which is straight on the top and not oblique. *Whorls* 9, straight or just faintly concave on the side, slightly scalar as they rise out of one another. The base is not in the least contracted, and is barely convex. *Suture* only recognizable from the slight shoulder of the whorl below it. *Mouth* small, angularly oval, with a blunt and laterally directed point above, and an oblique canal in front, which, relatively to the size of the mouth itself, is very large. *Outer lip* very straight, being neither incurved nor patulous, except round the edge of the canal, where it is slightly so. *Pillar* very short and conical, with an abrupt little, broad, parallel-sided style, with a very oblique, fine, rounded edge, and ending in a fine point on the left. *Inner lip* a fine glaze on the body and edge of the pillar. H. 0·19. B. 0·06. Penultimate whorl, height 0·028. Mouth, length 0·039, breadth 0·028.

This is a peculiarly beautiful shell, and, like *C. mamillanum* from the same locality, departing widely in sculpture from the coarse type common to the genus. From that species it differs markedly in its being much stumpier in form and in the carina being placed at the top and not at the bottom of the whorls. From *C. amblyterum*, another deep-sea form, and which it also resembles slightly, it differs in being stumpier and in having a much blunter and shorter apex.

17. Cerithium (Bittium) oosimense, n. sp.

May 14, 1875. Oosima, Japan.

Shell.—Small, broadish, conical, pointed, whorls angulated, semi-imbricated, corrugated longitudinally, not reticulated, tubercled, variced, thin, brownish grey, with white and brown spots. *Sculpture.* Longitudinals—there are on the penultimate whorl 13 depressed, rounded, slightly oblique ribs or corrugations, parted by furrows, shallow, rounded, and narrower than the ribs. These ribs diminish in number upwards on the spire, down which they run from whorl to whorl, with a slight oblique twist from left to right. On the last whorl one of these is strengthend into a feeble varix, but the rest become increasingly inconspicuous, and at last scarcely recognizable; on the base they are still traceable as faint corrugations. Spirals—each whorl, at about one fourth of its height from the suture, projects in an angular carination, which carries a small, but distinct rounded thread, rising into transverse tubercles where it crosses the longitudinal corrugations. Above this carinal thread there are four very small flat spiral threads, equal, and equally parted by three small furrows, in each of which lies a minute spiral thread. The furrow which separates the lowest of these four spirals from the carinal thread is plain, having no minute spiral in it. Below the carinal angulation the whorls are constricted. Within this constriction there are on each whorl two small alternating furrows and threads, then a comparatively broad and deep furrow, below which a small spiral thread lies immediately at the suture, but above it. It is this suprasutural thread which forms the edge of the base, and is there nearly as strong as the carinal thread. Its inner side is defined by a strongish furrow, within which the whole base to the point of the pillar is covered with small alternating threads and furrows, in number about 9, of which the first and the fifth thread are a little stronger than the rest. Besides these, the whole surface is microscopically covered with sharpish spirals and slight lines of growth. These last are very distinct toward the point of the pillar. *Colour* brownish grey, with porcellanous white spots where the spirals cross the corrugations, and with a good deal of suffused ruddy brown, especially on the base and about the suture; the edge of the pillar is deeply tinged with this colour. *Spire* pointed, conical, with straight profile lines, angulated by the pagoda-like projections of the whorls at the carina, and their constrictions below this into the suture. *Apex* small and rounded.

Whorls 11, of very gradual and regular increase, straight on the side, contracted upwards into the suture, and overhung by the projection of the preceding whorl above. The base is conical and very slightly concave. *Suture* invisible, though the situation is strongly defined by the suprasutural furrows. *Mouth* rather large, oval, bluntly pointed at the upper outer corner, and with a small open canal beyond the point of the pillar. *Outer lip* thin, corrugated, slightly expanded above, extremely patulous and projecting on the whole base, slightly pinched in at the side of the canal, advancing markedly beyond the point of the pillar, with a patulous and very slightly reverted sharp edge round the canal. *Pillar* straight, prominent, rounded, not short, but not projecting so far as the outer lip; its edge is finely rounded, but not sharp; its point is cut off quite straight, transversely, and is rounded. *Inner lip* a thin glaze on the body, but with a distinct edge, which is slightly thickened toward the point of the pillar. H. 0·21. B. 0·084. Penultimate whorl, height 0·035. Mouth, length 0·06, breadth 0·047.

The peculiar semi-imbricated growth of the whorls in this species recalls somewhat the curious *C. dubium*, Sow.; but the species differ obviously in size, form, and sculpture.

18. Cerithium (Bittium) cylindricum, n. sp.

April 17–18, 1874. Port Jackson, Sydney. 2–10 fms.

Shell.—Small, high, narrow, pointed, cylindrically conical, reticulate, tubercled, strong, dark brown. *Sculpture*. Longitudinals—there are on the last whorl about 25 narrow, posteriorly convex, curved riblets, which cannot be followed from whorl to whorl down the spire, and which hardly appear on the base amidst the strong curved lines of growth found there. These riblets are parted by squarish furrows about as broad as themselves. Spirals—there are on each whorl three pretty equal, squarish, not much prominent, spiral threads, which become prominent themselves and give prominence to the longitudinals by expanding into round-topped tubercles as they cross the riblets; they are parted by furrows, which are of about the same breadth as themselves; the sutural furrow is slightly deeper and broader than the others. The edge of the base is squarish, and is defined by a narrow sharpish-edged spiral thread. The base, which is flatly conical, is plain but for the lines of growth; the pillar is defined by a minute, sharpish spiral thread, which runs round its base and meets the slit of the canal. Besides these the whole surface of

the shell is microscopically scored with irregular lines of growth and fine spiral scratches. *Colour* dark ruddy brown, uniform all over. *Spire* high, narrow, pointed, with straight but slightly angulated contour lines. The first eight whorls expanding regularly, so as to form a minute cone, while the last four expand more slowly, so as to give more of a cylindrical shape. *Apex* small, blunt, rounded, slightly oblique, and a little immersed. *Whorls* 13, flat, except the last, which is slightly convex, with a somewhat flat but conical base. *Suture* in the bottom of a deep furrow is concealed by a projection of the inferior whorl. *Mouth* oval, with a small rounded sinus at the upper outer corner, and a largish and deepish canal running in behind the pillar. *Outer lip* not expanded, deeply corrugated by the ends of the spirals, with a deep V-shaped fissure forming the canal. *Pillar* straight, not short, pretty strong, with a rounded, narrow, twisted edge, and a small but not sharp point, which is very slightly reverted. *Inner lip* little more than a film on the body and pillar. H. 0·27. B. 0·064. Penultimate whorl 0·031. Mouth, length 0·042, breadth 0·028.

19. Cerithium (Bittium) abruptum, n. sp.

St. 75. July 2, 1873. Lat. 38° 38′ N., long. 28° 28′ 30″ W. Fayal, Azores. 450–500 fms. Sand.

Shell.—Small, narrow, conical, blunt, in general form very like a decollated *Cerithiopsis metaxa*, solid, translucent, white. *Sculpture.* Longitudinals—there are on the last whorl about thirteen, on the earlier, fewer longitudinal ribs, which are low and narrow, and are parted by flat and broader furrows. They come down the spire, from whorl to whorl, with a strong sinistral twist. The embryonic whorls have ten or twelve small ribs. Spirals—except on the first two whorls there are on each whorl four narrow, rounded, prominent spiral threads, which rise, as they cross the longitudinals, into pointed high tubercles. The furrows which part them (except that between the third and the fourth) are narrower than the spirals. The highest of these spirals is the weakest and least prominent, being pinched in by the superior contraction of the whorl into the suture. Close above this highest spiral runs the suture. The base of each whorl is roundly but rather abruptly contracted, so that the sutural furrow has its upperside abruptly, its underside gradually, declining. The base, which is oblique, concave, and contracted, has a strong plain spiral thread round its edge, and a very minute thread encircling the base of

the pillar, the scar of the siphonal cut. Besides the larger systems of sculpture, there are some faint and irregular traces of microscopic rounded longitudinals and sharper spirals. *Colour* translucent white. *Spire* high, narrow, with very straight outlines, and scarcely contracted. *Apex* excessively blunt and abrupt, the extreme point being rounded and barely rising into view; it is quite smooth and polished. The second whorl is longitudinally ribbed and polished; on the third the ordinary sculpture begins. *Whorls* 11, convex, constricted suddenly below and gradually above. *Suture* excessively minute and faint in itself, but its place strongly marked by the constriction of the whorls above and below. *Mouth* very small, oval, perpendicular, pointed above, and with a large open rounded slit in front, whose edge is hardly reverted. *Outer lip* thin, advancing on the base much beyond the point of the pillar. *Inner lip* a thin glaze, with microscopic corrugations on the pillar. *Pillar* very short, with a broad base spreading out to meet the outer lip, straight, with a broad but sharp point. H. 0·23. B. 0·05. Penultimate whorl, height 0·03. Mouth, length 0·028, breadth 0·02.

This species in general aspect is very like *Cerithiopsis metaxa*, della Chiaje, but differs in not having the sharp sculptured apex; the whorls, in consequence of the sutural contraction, are more rounded; the longitudinals are swellings of the whole shell, not, as in that other, mere projecting tubercles; the spirals are more definitely continuous; the longitudinal rows of tubercles run less definitely from whorl to whorl, and have a strong sinistral twist as they proceed down the spire, while in *C. metaxa* their continuous lines are very straight.

20. Cerithium (Bittium) delicatum, n. sp.

St. 135. Oct. 18, 1873. Nightingale Island. Tristão da Cunha Islands. 100–150 fms.

Shell.—Small, narrow, conical, blunt, with slightly convex outlines, rather tumid on the base, ribbed, but not reticulated, thin, translucent, glossy, white. *Sculpture.* Longitudinals—there are on each whorl about 17 narrow, straight, rather tumid ribs, parted by furrows of about the same breadth. These ribs run straight down the spire, but are on the body-whorl slightly oblique. This whole system of ribs and furrows ceases abruptly at the edge of the base through a levelling up of the surface. There are many microscopic rounded lines, which are most distinct in the furrows, but especially on the base. Spirals—there are faint

and minute spiral threads, best seen near the suture; and there are also indistinct close-set microscopic threads. The base of the pillar is encircled by a minute sharp thread, which is the scar of the siphonal cut. *Colour* clear, translucent, and glossy white. *Spire* high, narrow, with slightly convex outlines, which are strongly impressed at the suture. *Apex* rather abrupt, blunt and rounded; the extreme point hardly rises above the general curve. *Whorls* 9, rounded, but a little flattened on the sides, and constricted at the top and bottom of each; they are of slow and regular increase; the last is a little larger in proportion than the rest. The base is rounded and a little tumid. *Suture*, a minute line lying in a deep, open, and rounded depression. *Mouth* bluntly pointed above, with a rather broad rounded opening for the canal at the side of and behind the pillar. *Outer lip* rounded, slightly incurved above, patulous and projecting on the base, slightly retreating towards the canal, the edge of which is straight all round. *Pillar* rather short, but not stumpy, scarcely at all twisted, and very little truncated, the end being very much rounded, though there is a slight point on the left side. *Inner lip*. There is a very thin glaze on the body, which runs straight out on the pillar with a thinnish, but distinct edge. H. 0·133. B. 0·04. Penultimate whorl, height 0·02. Mouth, length 0·03, breadth 0·019.

In many of its features this shell is like a minute *Terebra*, but the form of the whorls rather suggests *Cerithium*. Unfortunately the canal is slightly chipped. It is much smaller than *Cerithiopsis costulata*, Möller; the ribs, too, are much smaller and the apex is more turbinate. Than *Cerithium Naiadis*, Woodward*, this species is much slimmer, and has not the well-marked spirals.

21. CERITHIUM (BITTIUM) AËDONIUM, n. sp. (*ἀηδόνιος*, belonging to a Nightingale.)

St. 135. Oct. 18, 1873. Nightingale Island. Tristão da Cunha Islands. 100–150 fms.

Shell.—Small, narrow, conical, blunt, with faintly convex outlines, which are deeply broken at the sutures, rather abruptly truncate at the base, reticulately tubercled, solid, translucent, glossy, white. *Sculpture.* Longitudinals—there are on the last

* Dr. Gwyn Jeffreys assures me this species of Woodward is really the same as the *Cerithiopsis costulata*, Möll. Not having opportunity now of comparing them, I state the fact on his authority.

whorl 19 rows of small, narrow, but longish, rounded, rather coarse tubercles, parted by furrows, which are shallow, rather unequal, and fully broader than the ribs. There are over the whole surface fine irregular lines of growth, which are, as usual, strongest on the base. Spirals—on all but the first two whorls there are three spiral threads, which rise into tubercles as they cross the longitudinals; they are parted by deep narrow furrows; of these three the two lower are strong, the upper of the two being a little the stronger and more prominent. The third and highest spiral is not materially smaller than the others, but is much less prominent, the whole whorl being at this part constricted. The suture lies immediately above this spiral. Beneath the lower spiral the whorl is sharply constricted, and a very minute plain spiral lies in the bottom of the furrow and immediately above the suture; this minute spiral is the edge of the strongish spiral which encircles the base. Round the base of the pillar is a minute sharp spiral thread, which runs round the back into the columellar canal. There are microscopic spirals over the whole surface. *Colour* pure translucent white. *Spire* is high and narrow; its outlines, which are a good deal interrupted by the sutural constriction, are slightly convex. *Apex*, of 1½ whorls, is tumid, bluntly rounded, a little oblique, and glossy white. *Whorls* 9, rounded, contracted above and constricted below. The base is rather truncate and rounded. *Suture* very minute, but well indicated by the broad open furrow in which it lies. *Mouth* oval, little pointed above, with a small well-rounded canal at the pillar. *Outer lip* sharp, scarcely incurved above, not prominent, but patulous below, angulated at the corner of the canal, round which it is scarcely reverted. *Pillar* straight, prominent, and pretty strong, with a sharp twisted edge at its point. *Inner lip* a mere glaze on the body, but forming a thin distinct edge along the length of the pillar. H. 0·17. B. 0·057. Penultimate whorl, height 0·032. Mouth, length 0·039, breadth 0·025.

This species is more like *Cerithium cinctum*, W., and *C. depauperatum*, W., than any thing else I know. These are both Madeiran species. Its whorls are much more rounded than in either of these. The base is not produced into a rounded cone as in *C. cinctum*, but is rather abruptly truncate and very slightly contracted; it is also plain, and has not the spiral threads which appear on these two species. The contraction of the whorls into the suture makes the outlines of the spire very different, and the apex

(which, as in the case of these two species, is mammillate and distinct from the acute form of *C. reticulatum*, della Chiaje) is more oblique than it is in these.

The last four species, *C. cylindricum, C. abruptum, C. delicatum*, and *C. aëdonium*, I keep here together. They have undeniably the deep oblique siphonal cut on the base toward the point of the pillar which is a very marked feature in *Cerithiopsis*; but the form of the canal is very variable in all the group, and the elongated and sculptured apex, which is a still more characteristic feature of *Cerithiopsis*, is wanting; and thus, in the absence of the animal and operculum, I prefer classing them as above with *Bittium*. I confess, however, that on both of these grounds *Cerithiopsis costulata*, Möll., seems quite as doubtfully entitled to rank as a *Cerithiopsis*.

Litiopa.

Litiopa (?) limnæiformis, n. sp.

St. 144 *c*. Dec. 27, 1873. Lat. 46° 48′ S., long. 37° 49′ 30″ E. Prince Edward Islands, between Cape of Good Hope and Kerguelen. 50–150 fms.

Shell.—Obliquely ovate, thin, smooth, whitish, horny, with a slight, almost covered umbilical chink. *Sculpture.* There are many faint oblique lines of growth, but none other of any kind. *Colour* whitish, horny. *Spire* conical, slightly scalar. *Apex* small, but bluntly rounded, and neither sharp nor sculptured. *Whorls* $3\frac{1}{2}$, of regular, but rather rapid increase, a little tumid, and convex, but flattened, in a line parallel to the axis; the base is tumid and somewhat produced. *Suture* strong, impressed, and almost a little canaliculate. *Mouth* perpendicular, oval, not at all pointed. *Outer lip* thin, a little incurved above, slightly patulous in front, and projecting beyond the pillar, between which projection and the pillar it retreats as a slight and open sinus. *Pillar* perpendicular, a little hollowed, twisted, and truncate. *Inner lip* spread out over the body-whorl and behind the pillar, so as to conceal and almost close the umbilicus, below which it crosses, with an oblique thin edge, to join the front of the pillar below its twisted truncation. *Umbilicus* not small in itself, but almost quite hidden. H. 0·089. B. 0·06, least 0·047. Penultimate whorl, height 0·02. Mouth, length 0·052, breadth 0·039.

This is another of the unsatisfactory cases where a species is classed under a genus for want of a better. The texture of the shell is somewhat like that of *Litiopa*, but it utterly wants the

pointed and sculptured apex; the truncation of the lip is blunt, and the species much more resembles a *Limnæa* than any thing else. There are no varices, nor any thickening of the outer lip, to connect it with *Alaba* (see Adams' 'Genera,' I. 241, and Ann. & Mag. Nat. Hist. 1862, x. 294, and E. A. Smith, P. Z. S. 1875, p. 537); and the truncated column distinguishes it from *Diala*. Of course if *Alaba* (*Diala*) *picta*, Ad., with a faint approach to a truncation, may be admitted to the subgenus whose characteristic features already at each important point contradict those of the genus itself, it is hard to say what may or may not be united to so elastic a group; but it seems safer at present to classify this species as a *Litiopa*, to which, at the same time, I do not believe it to belong.

CERITHIOPSIS.

1. *C. balteata*, n. sp. 2. *C. fayalensis*, n. sp.

1. CERITHIOPSIS BALTEATA, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

Shell.—Small, dumpy, oval, reticulate, tubercled, strong, yellow, with an inferior brown band. *Sculpture.* Longitudinals—there are on the last whorl about twenty rows of tubercles, parted by narrow, deepish furrows; they diminish in number on the upper whorls, but run very straight from whorl to whorl down the spire; they are largest and most widely parted on the penultimate whorl, being rather crowded and narrow on the last. Spirals—on each whorl there are two broad spiral threads, which rise into coarse rounded tubercles, of which the upper row is the stronger. The lower row is coloured brown. They are parted by a strong furrow. On the last whorl the upper spiral divides into two rather feeble ones, and the tubercles on the brown spiral diminish in size. On the contracted base is a small furrow, within which is a spiral broken into flat round tubercles. Within this is a squarish-cut furrow, and within this a small spiral forms the base of the pillar, which hardly projects beyond it. The whole surface of the shell is microscopically cross-hatched with longitudinal lines of growth and spiral scratches. These latter are strong on the point of the pillar. *Colour* is yellowish white, with a broadish spiral band of brown, which embraces the whole lower spiral. The whole surface is in this way pretty equally divided between a white and a brown spiral band. The brown colour is probably more crimson when the shell is fresh. *Spire* is short, contracting rather abruptly, with a convexly curved contour. *Apex* broken.

Whorls 7, excluding those of the embryonic apex, flat, contracted upwards on the spire, on the base contracted downwards and produced. *Suture* invisible, in the bottom of a deep narrow furrow. *Mouth* minute, roundly oval, with a rather large round canal, which turns in at the back of the pillar. *Outer lip* contracted. *Pillar* very short, strong, rounded and pointed. *Inner lip* thick and strong, and on the pillar projecting so as to leave rather a deep fissure behind it. H. 0·087. B. 0·045. Penultimate whorl, height 0·019. Mouth, length 0·016, breadth 0·014.

This beautiful little species very much resembles *C. pulchella*, C. B. Ad., from the West Indies; but that is a slenderer shell, being longer in proportion to its breadth, and has a longer pillar; its whole system of sculpture also is more delicate.

2. Cerithiopsis fayalensis, n. sp.

St. 75. July 2, 1873. Lat. 38° 38′ N., long. 28° 28′ 30″ W. Fayal, Azores. 450–500 fms. Sand.

Shell.—Small, narrow, conical, not contracted on the base, reticulated, tubercled, with a marked sutural furrow, of a light ruddy brown. *Sculpture.* Longitudinals—there are on the last whorl from 15 to 25 small, straight, longitudinal ridges, parted by narrow deepish furrows; they cross the whorls a little obliquely, and run pretty straight down the spire from whorl to whorl, with a slight sinistral twist. Spirals—there are on each whorl three equal rounded threads, which rise into rounded tubercles as they cross the longitudinal ridges; they are parted by rather narrow and deepish furrows. The bottom of each whorl is very slightly constricted into the sutural furrow, which is thus a little more distinct than the other furrows; and from this the succeeding whorl projects with a very straight and perpendicular edge. This furrow encircles the edge of the base, which is sharply defined and contracted by a spiral thread, whose rounded edge projects a little prominently on the inner side of the furrow. On the base the microscopic markings, irregular hair-like lines of growth, and very faint spirals are most visible. *Colour* uniform light ruddy brown. *Spire* high, narrow, pointed, very slightly scalar, with very slightly convex contour lines. *Apex* broken. *Whorls* (excluding the embryonic) 11, straight, or very slightly convex on the side; the base is very flat and hardly conical. *Suture* only recognizable from the furrow in which it lies. *Mouth* very small, narrowly oval, with a small, but well-marked sinus at its upper outer corner, and with a largish and

deepish canal turning in behind the pillar. *Outer lip* not expanded above, and but little so on the base; strongly furrowed by the spirals of the sculpture. *Pillar* short, stoutish, well rounded, fine-edged, obliquely truncate, and sharp-pointed. *Inner lip* a thin glaze on the body, but becoming thicker toward the point of the pillar. H. 0·173. B. 0·04. Penultimate whorl, height 0·02. Mouth, length 0·029, breadth 0·015.

This species seems to be somewhat variable in size, one of the five specimens which represent it being a good deal larger than the rest, with the same number of whorls. Another specimen is more dumpily conical.

It has some resemblance in a general way to *C. metaxa*, della Chiaje, but in that the contour lines are more regularly conical, the spire is not at all scalar, the whorls are convexly rounded, there is no deep sutural furrow, the tuberculations are long across the shell, and each whorl has four, not three spirals; the form of the base is a good deal like, but the pillar is shorter, stronger, straighter, rounder, and has not the sharp flanged edge of that species. From *C. tubercularis*, Mont., which it resembles in sculpture, it differs not only in its slender form, but in the absence of the circumcolumnar thread on the base.

Note on an Abnormal (Quadriradiate) Specimen of *Amblypneustes formosus*. By Prof. F. Jeffrey Bell, M.A., F.R.M.S.

[Read April 15, 1880].

(Plate V.)

It is now forty-three years since that accurate and painstaking zoologist Rudolph Philippi described a monstrous specimen of *Echinus melo* *, which was especially remarkable for the excentric position of the mouth and of the anus, and for the almost complete disappearance of one of the five segments of which the test of every Echinid is typically composed. Being at present engaged in an examination of the group to which the name of Temnopleuridæ has been applied, I have, among others, taken in hand the three specimens of *Amblypneustes formosus*, which, named by Prof. Alex. Agassiz, have come as an earnest of the harvest of the 'Challenger' Expedition. The smallest of these at once arrested my attention by the curious asymmetry which revealed

* Arch. für Naturges. iii. (1837), p. 241, pl. v.

itself even to the touch; when the spines, light green at their base, were removed, I saw, what indeed I had long hoped to see, evidence that even among the regular Echinoidea circumstances may obtain which lead to the incomplete development of that pentamerous arrangement of parts which is the general rule among the Echinodermata. Just, however, as in Dr. Philippi's *Echinus melo,* indications of the fifth segment can be observed on the actinal surface, though they are not so well marked as in that form, for there is, apparently, no representative left of the interambulacral series, and there is not so large a number of ambulacral pores.

Adopting the ordinary mode of orientation of the test, or, in other words, regarding the madreporic plate as being placed in the right anterior interambulacrum*, we find that the abactinal region has been pushed backwards, and that it is some of the parts on the left side of an axis drawn through the median ambulacrum anteriorly and the median interambulacrum posteriorly that have undergone loss. Closer examination reveals the fact that it is here, just as in *Echinus melo,* the left anterior segment or area which has thus suffered: the actinostome has been pushed forwards and to the left. Turning now to the abactinal region, we find that it is composed of ten plates. This is especially interesting, inasmuch as Philippi's specimen presented a tetramerous arrangement of the plates of the abactinal area The two genital plates in the modified area are small, the ocular between them has become considerably enlarged, is obtusely triangular, and has its apex directed downwards. About nine plates down the side of the test the characters of the bare median space alter in character: there is a moderately sized and then a large tubercle; about halfway between these and the regular row of primary tubercles there is, on either side, a sutural line; and the two lines unite above the just-mentioned moderate tubercle; so that, as it seems, a wedge-shaped piece is intercalated into the side of the test; and we have first a large single plate, and then, as is shown by the presence of three primary tubercles on either side, there are three pairs of coronal plates, while on either side of these there are seven pairs of ambulacral pores.

From this description it should be apparent that at a compara-

* The magnificent researches of Lovén confirm the results of earlier Echinologists. "Études sur les Echinoïdes," Kongl. Svenska Vetenskaps-Akad. Hand. Band. ii. no. 7 (1872).

tively early period in its life-history the specimen of *Amblypneustes* now under description met with some powerful external influence, which affected the development of one of its five areæ; the plates that had been formed were, with the growing down of the neighbouring plates towards the actinostome, gradually forced down and off. At the period of its capture some three pairs of complete plates remained to give an indication of its experiences; had its capture been a little delayed, the plates of the fifth segment or area might have been completely forced off; and a specimen which would perhaps have been unique among recent forms would have been collected by the officers of H.M.S. 'Challenger.' What has been prevented here may, however, some day happen. One such test has already been preserved as a fossil. This, fortunately for the credit of science, came into the hands of Hermann von Meyer, who, far from elevating it into a new genus, put on record his belief that it was not even specifically separable from the *Cidarites coronatus* * of Goldfuss. Von Meyer's specimen does not appear to have presented any indications of injury. The chief object of the present communication is to make any other course than such as this extremely difficult. The zoologist who proposes to differentiate a quadriradiate species, on the ground of the absence of one area, will first have to show that the specimens in his hands have not suffered from some accident.

With more or less reason, some naturalists have looked on the possession of other than five rays as a character of some specific value among the Asterida and Ophiurida, and have considered that, on account of its greater rarity among the latter, it is of greater value as a mark of distinction. There is much to be said for this view, but it must not be carried too far; and even without the restrictive influence of Dr. Philippi's abnormal *Echinus melo* and this *A. formosus*, a naturalist would be hardy indeed who would ascribe to a difference in the number of rays of a regular Echinid any other value than that which is justly due to an interesting accident.

Dr. Philippi, indeed, concludes his notice of his monstrous form by saying, "Ueberhaupt scheint bei den regelmässigen Echiniden die Natur nicht selten wenig auf die Symmetrie der einmal vorkommenden Organe zu geben;" and he instances the four anal plates of *Echinocidaris* and the strange elongation of *Echinometra*. As to the former case, on which I will now only

* Nova Acta Leop.-Car. Acad. xviii. i. (1836) p. 287.

make any observation, it may be pointed out that the anal plates are hardly to be compared with any part of the corona or of the genital or ocular plates. The anus is, as Prof. Lovén tells us *, "produit par une résorption locale de la substance calcaire;" even if the anal plates have a deeper morphological significance, they are not so constantly four in *Echinocidaris* as has been ordinarily supposed †.

The pentamerous arrangement of parts in the regular Echinida is, then, only disturbed heretofore in one example‡; information and specimens are, however, at hand to show how this may have happened; the rarity of any divergence from this five-part disposition, in face of the numerous variations which occur in other Echinodermata, will doubtless become more and more important as a factor in determining the genealogical history of the group.

The following are the more important measurements of the specimen (in millims.):—

Diameter.	Height.	Abactinal area.	Anal area.	Actinostome.
13·5	11	3·5	1	5·5

The specimen was collected at Station 162 (off East Moncœur Island; depth 38 to 40 fathoms).

DESCRIPTION OF PLATE V.

Fig. 1. Test, seen from abactinal surface.
2. Test, from actinal surface.
3. Apical area.

The lettering to the above figures applies as follows:—*ia*, interambulacral, *ap*, ambulacral plates; *m*, madreporic plate; *o*, ocular, *g*, genital plates.

For figs. 4, 5, and 6, see Mr. Stewart's paper, *posteà*.

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* "Études sur les Échinoïdes," Kongl. Svensk.Vetensk.-Akad. Handl. ii. no. 7, p. 90.

† Proc. Zool. Soc. London, 1879, p. 436.

‡ [Mr. Stewart's example of an opposite kind of malformation was not known to me when this paper was written.]

Note on an Abnormal *Amblypneustes griseus*. By CHARLES STEWART, F.L.S., Lecturer on Comparative Anatomy, St. Thomas's Hospital.

[Read April 15, 1880.]

(PLATE V.)

HEARING that Prof. F. Jeffrey Bell was about to give before this Society an account of an abnormal *Amblypneustes*, in which the upper portion of an ambulacrum was deficient, with an associated abnormality of the apical system of plates, I thought that a short note on a malformed *Amblypneustes* in my own cabinet might be of interest in relation to it.

The specimen in question is one of the red-spined variety of *A. griseus*, which measures 16 millims. in height and $19\frac{1}{2}$ millims. in breadth. Attention is at once attracted by a crest-like elevation of what appears to be one of the ambulacra, which throughout its entire length is raised above the general level of the rest of the corona. At the ambitus it measures 12 millims. in breadth, whilst the width of the four other ambulacra is $6\frac{1}{2}$ millims. On examination, it is found that the increased size is really due to its being formed of two ambulacra laying side by side; each, as usual, is composed of a double row of plates, with an ambulacral area and two poriferous zones. The areas and external poriferous zones are like those of a normal ambulacrum; but the poriferous zones which touch one another are fused together, with the pores irregularly arranged. The combined poriferous zones are not quite equal to the sum of two normal ones, and they form the most prominent part of the crest alluded to. The apical system is quite normal. Owing to the close crowding of the tubercles and the slight development of the pits at the angles of the plates, the outlines of the latter were difficult to determine.

The chief interest, then, in this specimen lies in the fact of its abnormality being in direct opposition to that described by Prof. F. Jeffrey Bell (preceding paper), namely, instead of a reduction we have here an increase in the number of ambulacra. The two cases well illustrate Echinoid irregularities, and may lead to other instances being noted.

DESCRIPTION OF PLATE V.

Figs. 1, 2, and 3 are referred to in Prof. Bell's paper, *anteà*.

Fig. 4. Enlarged diagrammatic side view of corona. A, ambulacra.

5. Enlarged diagrammatic aboral view.

6. Portion of abnormal double ambulacrum, $\times 7\frac{1}{2}$ (semidiagrammatic).

On *Limnocodium victoria**, a new Hydroid Medusa of Fresh Water.

By Prof. G. J. Allman, M.D., LL.D., F.R.S., President L.S.

[Received June 14, 1880; Read June 17, 1880.]

I am indebted to Mr. Sowerby, of the Botanical Society's Gardens in Regent's Park, for having called my attention to the fact that certain medusoid organisms had shown themselves in the gardens, where they had become developed in great abundance in one of the warm tanks devoted to the cultivation of the *Victoria regia.*

So startling a fact as the occurrence of a medusa in fresh water demanded immediate examination, and, through the kindness of Mr. Sowerby, I was enabled to make a careful study of the remarkable phenomenon to which my notice was drawn by him.

A visit to the tank made apparent the correctness of Mr. Sowerby's observation, for the water, which had a temperature of 86° Fahr., was literally swarming with little medusæ, which varied in size from about a line in transverse diameter to nearly half an inch. They were most energetic in their movements, swimming with the characteristic systole and diastole of their umbrella, and apparently in the very conditions which contributed most completely to their well-being.

A closer examination showed them to be true hydroid medusæ, and revealed some very interesting structural features. The umbrella varies in form with the state of contraction, passing from a somewhat conical shape with depressed summit, through figures more or less hemispherical, to that of a shallow cup. The radiating canals are four in number and open into a wide marginal canal; and the manubrium is large and, when extended, projects beyond the margin of the umbrella; its lips are destitute of tentacles, but everted and plicated (fig. 2).

The marginal tentacles are filiform; they are numerous, nearly 200 in old individuals, and are of unequal size. The longest and thickest correspond to the points where the four radiating canals open into the marginal canal. In each interval between these, and at equal distance from one another, occur seven somewhat smaller tentacles, and between these again other still smaller ones. The velum is of moderate width, and the extreme margin of the umbrella is wavy and thickened and loaded with brownish-yellow pigment-cells.

* Instead of "*victoria*," Prof. Lankester employs the specific name *Sowerbii*, after Mr. Sowerby, the discoverer of the medusa—a modification of the nomenclature used above, which I am quite willing to adopt.

The marginal bodies are about 128 in number, and consist of a highly refringent spherical corpuscle surrounded by a delicate transparent capsule. This capsule is very remarkable, for, instead of presenting the usual spherical form, it is of an elongated piriform shape. In its larger end is lodged the spherical refringent body, and it thence becomes attenuated, forming a long, tubular, tail-like extension, which is continued into the velum, in which it runs transversely towards the free margin of this membrane, and there, after becoming more or less convoluted, terminates in a blind extremity (fig. 3).

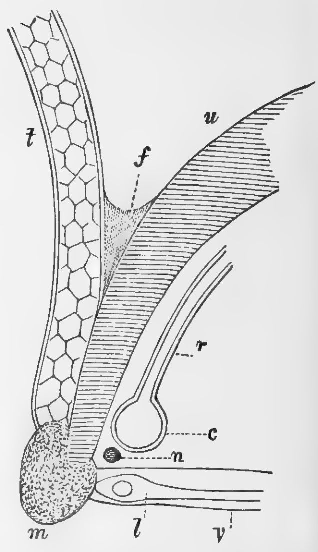
The reproductive sacs are borne on the radiating canals at a short distance beyond the exit of these from the manubrium. They are of a piriform shape, and spring by their narrow ends from the canal, whence they hang down free into the cavity of the umbrella. Their colour is a brownish yellow, derived from the pigment-cells developed in their endoderm.

The manubrium is of a similar brownish-yellow colour, due also to the pigment-cells of its endoderm.

The following notes have been made since the above was received:—

The attachment of the tentacles is peculiar. Instead of being free continuations of the umbrella-margin, they are given off from the outer surface of the umbrella, at points a little above the margin and at three or four different levels. From these points, however, each may be traced centrifugally in the form of a ridge as far as the thickened umbrella-margin (fig. 1). This ridge consists of the proximal portion of the tentacle, which is here adnate to the outer surface of the umbrella. It holds exactly the position of the "Mantelspangen," or *peronia*, so well developed in the whole of the Narcomedusæ of Häckel and in some genera of his Trachomedusæ*. Its structure, however, differs from that of the true *peronia*, which are rib-like lines of thread-cells marking

Fig. 1.



Diagrammatic meridional section of Medusa through a radial canal.

u, umbrella; *m*, thickened and pigmented margin; *v*, velum; *l*, lithocyst; *r*, radial canal; *c*, circular canal; *n*, nerve-ring; *t*, tentacles; *f*, frenum.

* Relations of *Limnocodium* to the Trachomedusæ are maintained by Prof. Lankester, who refers the medusa to the Trachomedusal family *Petasidæ*. See 'Nature' for June 17, 1880, and his paper of the same date read at the Royal Society.

the path travelled over by the tentacle as its insertion moved in the course of metamorphosis from the margin of the umbrella to a point at some distance above it; while in *Limnocodium* the ridges are direct continuations of the tentacles, whose structure they retain. They suggest a comparison with the root-like continuation of the tentacles, which are plunged into the substance of the umbrella in the Narcomedusæ and in certain Trachomedusæ. Just before reaching the margin they become narrower, and are ultimately inserted on the summits of the sinuses into which the thickened margin is thrown. The intrant angle between the free portion of the tentacle and the umbrella is rounded off by a frenum-like extension (fig. 1, *f*) of the outer epithelium of the umbrella.

I could find no indication of a cavity in the tentacles, a feature in which they resemble the solid tentacles of the Narcomedusæ and Trachomedusæ. Instead, however, of possessing the peculiar axis composed of large cylindrical or disk-shaped cells laid one on the other like coins in a rouleau, which is so prevailing a characteristic of the tentacles in these orders, the axis is here formed of an irregular tissue of polygonal cells. This pith-like axis is surrounded by a membranous tube (which probably consists of the "Stützlamelle" with muscular fibres), and this, again, by a layer of flattened membraneless cells, whose confluent walls form a continuous naked protoplasmic stratum, which is raised into numerous small conical elevations arranged somewhat spirally round the tentacle from its base to its apex. In each of these little protoplasmic tubercles are imbedded three or four very minute fusiform thread-cells, the distal ends of which may be often seen projecting beyond the summit of the tubercle.

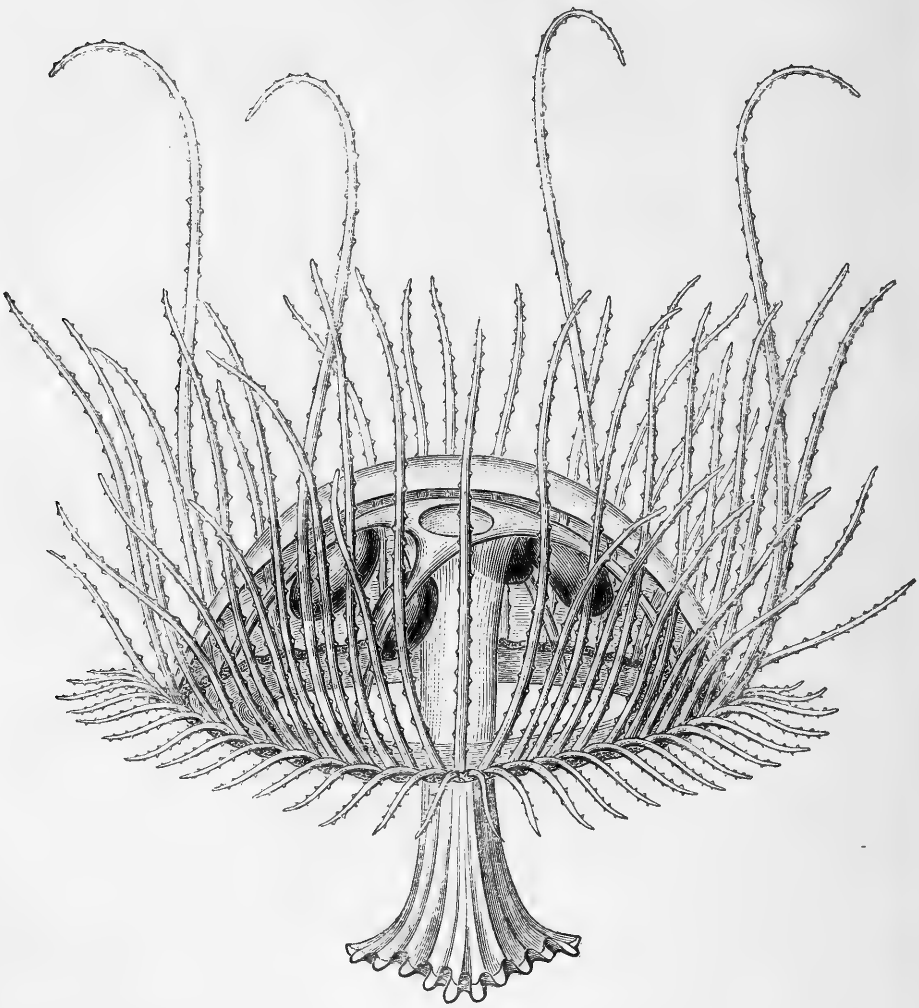
A further affinity of *Limnocodium* may be traced in the direction of *Obelia*, as shown not only by the tentacles being in both destitute of a cavity, but by the fact of their not being free in their entire extent, for in *Obelia* the basal end is plunged, in the form of a root-like continuation, into the substance of the umbrella. Though *Obelia* is in systematic descriptions included among the Leptomedusæ, I have elsewhere pointed out indications of affinity between it and the Narcomedusal form *Cunina**. Its affinity with the Trachomedusæ is still closer; but from both groups, as well, indeed, as from the Leptomedusæ, a marked point of divergence is found in the suppression of a velum.

Notwithstanding the absence of a cavity, the tentacles of *Limno-*

* British Association Reports for 1867.

codium differ from those of the Trachomedusæ and Narcomedusæ, as well as from *Obelia*, in their great extensibility, the four primary or perradial tentacles admitting of extension in the form of long, greatly attenuated filaments to several times the height of the vertical axis of the umbrella, even when this height is at its maximum, and being again capable of assuming by contraction the form of short thick clubs. Indeed, instead of presenting the comparatively rigid and imperfectly contractile character which prevails among

Fig. 2.



The Medusa with its tentacles extended, and the umbrella in a medium state of contraction. Magnified about 8 diameters.

the Trachomedusæ and the Narcomedusæ, the tentacles of *Limnocodium* possess as great a power of extension and contraction as may be found in those of many Leptomedusæ (*Thaumantidæ* &c.).

The four perradial tentacles contract independently of the others, and seem to form a different system.

The outer surface of the umbrella (exumbrella) is covered with an epithelium composed of flattened hexagonal cells, with very distinct and brilliant nucleus. The subumbrella is also covered with an epithelium formed of broad clear hexagonal cells, in which the nuclei are distinct, but the cell-boundaries far less obvious than in the outer epithelium.

Between these two layers is included the gelatinous substance of the umbrella. This is a clear homogeneous mass with stellate cells scattered through it. The stellate cells consist of small spherical masses of granular protoplasm, destitute of a membrane, usually containing a vacuole, and emitting from two to six long, radiating, very slender, simple or branched processes, which are extensions of their granular substance.

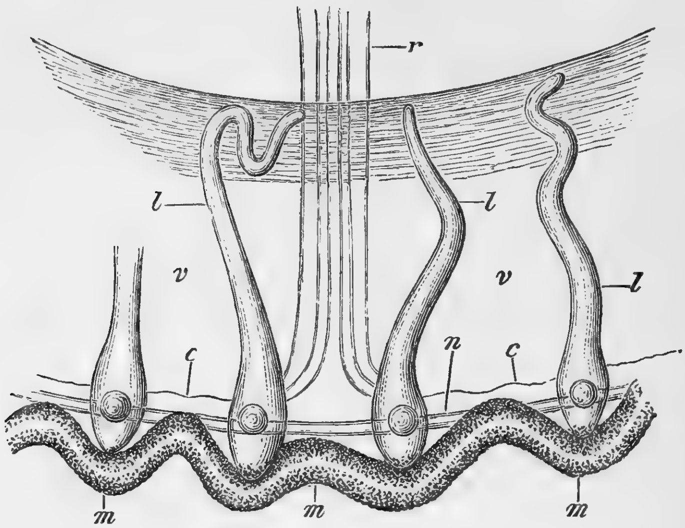
The manubrium is composed of an outer, clear colourless ectoderm and an inner, coloured endoderm. The ectoderm is a continuation of the epithelial covering of the subumbrella, here much thickened, and consisting, like it, of hexagonal nucleated cells. The endoderm, in that part of the manubrium which lies between its dilated base and the mouth, is composed of narrow prismatic cells, whose long axes are perpendicular to the surface, and which contain granules of a yellowish-brown, or, in some specimens, of a greenish colour. The endoderm of the wide basal portion of the manubrium is very remarkable. It consists of a greatly vacuolated granular protoplasm, in which every vacuole contains a distinct granular nucleus. These vacuoles may be regarded as representing the cavities of so many membraneless cells whose boundaries, in consequence of the confluence of their walls, are no longer obvious. This form of tissue, which may be also found in the manubrium of other hydroid Medusæ, passes into that formed by the prismatic cells of the rest of the manubrial endoderm.

The radial canals consist of a thin ciliated endodermal layer continued from the endoderm of the manubrium and surrounded by a thicker ectoderm, which is composed of hexagonal nucleated cells and continued from its ectoderm. Between the ectodermal and endodermal layers is a distinct fibrillated layer, the fibres of which, after accompanying the canal to the point where this enters the marginal canal, here spread out on either side and lose themselves in the subumbrella. Beside these longitudinal fibres, the indications of a fibrillated tissue in the subumbrella are very

indistinct—a condition which contrasts strongly with the highly developed musculature of the subumbrella in the Trachomedusæ.

The velum is composed of two layers of nucleated cells having between them an annular layer of muscular fibres ; while between the muscular layer and the lower or abumbral cellular layer are the marginal vesicles, with their caudal extensions running from the attached to the free edge of the membrane.

Fig. 3.



Part of the margin, enlarged.

m m m, thickened and sinuated margin ; *v v*, velum ; *l*, *l*, *l*, lithocysts ; *r*, radial canal ; *c c*, circular canal ; *n*, nerve-ring.

The reproductive elements are developed between the endodermal layer (spadix) of the sporosac and its ectodermal layer. I believe they take their origin in cells of the endoderm. After a sporosac has become naturally emptied of its contents, it will be found that the space which these had occupied between the endoderm and ectoderm is now traversed by irregular bands of granular protoplasm, which extend from the walls of the spadix internally to the ectoderm externally, being attached by their ends to both these membranes. Some of these bands are simple, others branched. They present here and there fusiform enlargements irregularly distributed along their length.

In many instances a thin layer of clear spherical cells may be seen still closely adhering to the spadix. These I regard as the remains of the spermatogenic tissue ; and their intimate relation with the walls of the spadix, while they are separated by a wide

interval from the outer ectodermal walls of the sporosac, is quite in favour of the endoderm being the seat of their origin.

The marginal nerve-ring can be traced running round the whole margin of the umbrella, and in close relation with the lithocysts*. A filament is given off from it in each of the four interradial spaces, and thence ascends in the subumbrella between the radial canals. Ocelli are not present.

The refringent body which occupies the interior of the lithocyst consists of an aggregation of highly refringent spherical corpuscles. I have counted from five to ten such spherules in a single lithocyst. This structure becomes very obvious in specimens which have remained for a day or two in a weak magenta solution†.

The generic characters of *Limnocodium* may be brought together as follows:—

Genus Limnocodium (*λίμνη=pond, κώδων=bell*).

Radial canals 4, each carrying a single reproductive sac; manubrium destitute of peduncle, 4-lipped; marginal tentacles filiform, solid, very numerous, adnate to the outer side of the umbrella for some distance from their insertion into its thickened and sinuous margin; marginal vesicles each sending into the velum a tubular extension, which terminates blindly at the free edge of this membrane.

* The terms "otocysts" and "otolites," employed for the marginal bodies of a medusa, are very unsatisfactory. Their significance depends on the assumption that these bodies are organs of hearing. Their being endowed with an auditory function, however, is very far from having been proved. Mr. Busk had long ago given morphological reasons for regarding them as organs destined to receive and transmit impressions of light, while the recent beautiful physiological experiments of Mr. Romanes give results which point quite in the same direction. Though observation is thus in favour of ascribing to the marginal bodies of the Hydroid Medusæ a photæsthetic function, the very convenient term of "lithocyst" proposed for them by Prof. Huxley, involving, as it does, no idea of disputed function, may be adopted with advantage.

† To this peculiar structure of the otolite my attention was first called by Mr. Busk.

On an unusual Form of the Genus *Hemipholis*, Agass.

By Prof. P. M. Martin Duncan, F.R.S., F.L.S., &c.

[Read May 6, 1880.]

(Plate VI.)

Amongst some dredgings from off the Agulhas Bank, south-west of the Cape of Good Hope, given to me by Dr. Wallich, I found several small Ophiurans. One of them struck me at once as presenting a very unusual combination of structures. The disk was symmetrically plated above, the arms were almost moniliform and had a few spines projecting from their sides, and the oral apparatus, elongated downwards, had its teeth in close apposition. A non-plated skin covered the interbrachial spaces; and no proper mouth-papillæ or tooth-papillæ were visible. These characteristics were so suggestive, that a careful examination of the form was necessary.

The specimen is a dry one and brilliantly white in colour. The disk is slightly pentangular in outline, and it is tumid above, where it is covered with a few large and regularly placed plates united at their edges.

There is a large central rosette occupying the greater part of the upper surface, and the central plate (a regular pentagon) is the largest. The other five which surround it are slightly smaller, and are united to it and to their neighbours by straight edges. Their external margin is curved, and they are rather unequal in size.

The radial shields are large, and some are separated, orally, by a minute triangular scale, which is in contact with one of the plates of the rosette; but where this scale does not exist, the radial shields are united together, and are in broad contact with the outer rosette-shields.

Their distal margin is broad, sharp, and slightly incurved where it arches over the upper surface of the arm. In the interradial spaces there are only two plates, which are large, one being in contact with the rosette and the other extending to the margin of the disk, where it ends in a sharp edge.

Underneath, the disk is more pentagonal in outline than when seen from above, and the margin is sharp and distinct. There are no plates in the interbrachial spaces; but there is a skin there, which is covered with a very delicate cellular coat.

The mouth-shields are small and triangular in outline; they are about as long as broad, are pointed orally, and are outwardly curved distally. Their position is very oblique; and their free surface passes downwards and inwards, so that the proximal end is on a lower plane than the broad distal curve. The sides are slightly incurved.

The side mouth-shields are very small and narrow; they do not meet orally, and they are as long as about one half of the side of the mouth-shield. Each supports a long and slender spinule, which projects downwards and slightly outwards, and is situated at the end of the inner third of the shield and ab-orally to a large tentacular opening. The oral ends of the jaws are close together, and are on a lower plane than the side mouth-shields; hence the jaws and the lowest true teeth project downwards. Their mutual contact forms a small pentagonal area with curved edges, closed by the lower teeth; and this is at the end of a process which projects downwards in consequence of the downward curving of the jaws.

There are thus no true mouth-papillæ, and tooth-papillæ are absent. The first tentacle-spine is not visible high up at the side of the jaw, and the spaces between the jaw-angles are nearly covered with a delicate skin. The lowest tooth of each jaw is in close contact with its neighbours; they are all on a level plane and completely close the oral passage. The teeth are triangular in outline. The spaces between the jaw-angles are mere slits, and no tentacle passes through them. The first tentacle is in the place occupied in other forms by the second tentacle, and it is large and in relation to the spine on the side mouth-shield. This spine, according to ordinary terminology, would be a mouth-papilla, so that each angle has two of these.

The arms, five in number, are unequal in size; and there are only two joints within the disk, but they are broad, and encroach upon the interbrachial spaces.

The first lower arm-plate is very small, and is faintly covered with the extension of cellular skin; and its shape is rather that of a hatchet. The distal edge is the broadest, and is curved distally, whilst the inner or oral edge is narrow. The sides are greatly incurved for the tentacular opening. The second plate, small and about as broad as long, is broadest aborally, where it is boldly curved. It is narrowest orally, where it is in relation to

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a space covered with skin between the side arm-plates. The sides are re-enteringly curved, and much of their space corresponds to the large tentacular opening. The third, fourth, and fifth lower arm-plates correspond in shape with the second; but towards the tip of the arm the plates become smaller and longer than broad and more constricted.

The upper arm-plates are slightly broader than long, and are convex from side to side; they are boldly curved distally, and their sides are outwardly curved. The first is hidden, and the second is partly hidden proximally, by the meeting of the side arm-plates. Towards the tip they become longer than broad and rather angular distally. The side arm-plates form much of the arm, and meet, both above and beneath the arm, along the median line, and they form a long cylindrical tip to the arm. They are narrowed just beyond the upper arm-plates; they then swell out and have convex sides. They are long, down the arm, and three long, sharp, slender spines are on each near the disk; but further out two are seen on either side. The spines project outwards from the arm, and are as long as the side arm-plate, or longer. The lowest spine is the smallest; and it is so placed on the lower aspect of the side arm-plate as to occupy the position of a tentacle-scale; it projects downwards and sideways. Beneath the arm the side arm-plates are large, and their length of median junction is greater than above. The first pair are large, are united orally, and in the midst, but at the distal end there is a space which has already been mentioned, and it elongates towards the tip of the arm. There are no proper tentacle-scales, and the tentacles are long and stout.

The colour of the specimen, which is dry, is white, and the upper arm-plates are beautifully cellular.

The length of the specimen is about $\frac{1}{8}$ inch.

Locality. Agulhas Bank. Collected by Dr. Wallich.

Remarks.—Although the specimen to which this description alludes is young, it is not immature, except in regard to the ends of the arms. Its large plating on the disk, the naked under-disk, the downward projection of the oral apparatus, the absence of true mouth- and tooth-papillæ, the comparative occlusion of the interangular spaces, and the close fitting of the triangular-shaped teeth, one and all, belong or relate to an Ophiurid which has all its normal and most of the adult structures.

The zoological position of the form is not without doubt; for

the classification of the Ophiuroidea is at present full of anomalies, and the admission of unusual forms into any group is beset with difficulties. The naked interbrachial spaces and the paucity of oral accessories (admitting, for the sake of argument, the spines on the side mouth-shields to be "mouth-papillæ"), and the general shape and anatomy of the arms, permit of the association of the species with *Hemipholis*, Agass. But the great plates on the upper part of the disk are not invariable in the genus, and the long curved and downward projecting jaws would be abnormal to it. This genus, however, is the most convenient, and therefore I place the species therein, subject to the concurrence or opposition of a classificatory dogma which insists upon the primary value of characters relating to the very variable dermal structures.

But the zoological position is the least important part of the environment of this remarkable species. The nature of the so-called dental or "chewing" apparatus is full of interest; and its consideration suggests the necessity of employing new terms and of deciding the physiology of the oral structures.

The mouth-papillæ of Ophiurans, whatever may be their number, breadth, or length, should arise from the sides of the jaw-angles; and there are instances where they may originate at the junction of the jaw and the side mouth-shield. The origin of a mouth-papilla from the side mouth-shield alone is often seen, and it is always in relation to the tentacle-opening close by. Another mouth-papilla is said to exist high up in the jaw-angle, and it is close to the first tentacular opening. It is clear, to my mind, that the so-called mouth-papillæ arising from the side mouth-shields, and also those coming from the side of the jaw close to the first tentacular opening, are more or less modified tentacle-scales, and should be called tentacle-scales or spines. They may be absolutely like tentacle-scales or sharp spines. Tentacle-scale is therefore their proper name. This will restrict the term mouth-papilla to its proper limit, on the lower sides of the angles and below the jaw-plate. They partly cover over the lower outlet of the jaw-angle, whose cavity communicates with the true oral passage. They are dermal structures. In the species now under consideration the derm from the sides of the jaw-angles is not in the form of denticulations, spinules, or angular processes, but is a lamina, so closely approximated to that of the neighbouring angle-side that a mere slit exists, so perfect is the closure. The use of this dermal prolongation, this continuous analogue

of the mouth-papilla, is the same (but in a greater degree) as that of the ordinary mouth-papillæ at the sides of the jaw-angles. All are filterers, and prevent large pieces of substance from entering the digestive cavity. So far as the mouth-papillæ of many genera are concerned, their shape and position contraindicate the possibility of any individual movement of the jaw-angles towards or from the oral axis.

It is evident that the specimen under examination has the true teeth horizontally placed, although the position of the jaws, and necessarily of the jaw-plates, is oblique, and also that these triangular teeth are so closely in apposition that no substance of a visible size can pass up into the stomach.

In the Ophiuroidea, as a whole, there is a gradation between this almost occluded condition and a wide separation of the points of the true teeth after death. The true teeth are attached at right angles to the long axis of the jaw-plate, which is fixed externally to the jaw, and they project into the canal leading to the stomach according to their size. Sometimes pointed bluntly, they are at others broad, and are either convex or concave at their free internal surface. They are capable of passive up-and-down flap-like movement to a slight degree; but the statement that they are fixed on to the jaw-plate by muscles I have not been able to verify. Certainly no muscular fibres like those in the arms are to be found; and the substance which really connects teeth and jaw-plates is connective tissue. The microscopic character of the so-called teeth in the majority of instances indicates that the granules of calcareous matter are arranged more or less in a cellular fashion. There is nothing like a worn surface to be seen on any of the teeth, which in some genera are finely ornamented with spinules; and, indeed, usually they have an axial space between their free internal edges.

There may be a dermal growth below the end of the jaw-angle; and this may be of all shapes, from the nodular to that of a true tooth. It is a mouth-papilla according to systematic writers, and probably correctly so. Often sufficiently difficult of distinction from the lowest true tooth, this papilla has the same physiological significance.

In several genera, *Ophiothrix* being the best example, a number of dermal spinules of different lengths are arranged on the inner side of the lower end of the jaw-plate, in the position of the lowest true teeth; they are the dental tooth-papillæ. Usually

their free surface slants downwards and outwards and away from the axial line. They clearly cannot be approximated to chew.

The use of the teeth and other structures on the end of the jaw-angle and of the tooth-papillæ is to filter the water which is constantly passing into the stomach, to keep out particles which might be too large and also living intruders. A movement of the jaw-angles towards each other and the central axis of the mouth, sufficient to bring the teeth in forcible apposition, does not seem possible. But in some species there is a slight enlargement possible of the so-called mouth; and the series of teeth of each jaw-plate may be more or less distant from their fellows. Contraction, however, beyond a certain limit would cause crushing of the delicately spinuled teeth of such forms as *Ophioscolex*. The enlargement of the mouth and consequent separation of the jaws is common in those genera the species of which can move the arms upwards; but this appears usually to be a convulsive action preceding death, a *rigor mortis* determines the persistence of the condition, and *post mortem* rigidity permanently widens the space between the jaw-angles in many forms. Nevertheless there are species which have the circle of side mouth-shields discontinuous, whose arms are capable of a slight upward and aboral movement, and whose mouth-canal can be widened and narrowed during life. Mr. W. Percy Sladen, F.L.S., is now investigating the disk and arm attachments and insertions of some hitherto unnoticed muscular slips which appear to explain this movement.

I have named this species after its discoverer, *Hemipholis Wallichii.*

EXPLANATION OF PLATE VI.

Fig. 1. *Hemipholis Wallichii*, Duncan, about nat. size.
2. The under part of the disk and arms, magnified.
3. The upper part of the disk and arms, magnified.
4. Diagrammatic section from above downwards of the disk, showing the projecting spine on the side mouth-shield.
5. Arm-spine, magnified.

On the Tusks of the Fossil Walrus found in the Red Crag of Suffolk. By E. Ray Lankester, M.A., F.R.S., F.L.S., Professor of Zoology and Comparative Anatomy in University College, London.

[Read May 6, 1880. Abstract.]

In this communication (which will be published in full in the Society's Transactions, with illustrations) the author explains that, at the suggestion of Prof. P. J. van Beneden in 1864, he had generically named the fossil Walrus-tusks obtained from the Suffolk Crag *Trichecodon*, and that in his account of the specimens published in the Geological Society's Journal, 1865, they accordingly were denoted as *Trichecodon Huxleyi*. With more perfect specimens since at his command, he now withdraws the generic term, substituting that of *Trichechus*, desiring that the remains then and now described should hereafter be recognized as *Trichechus Huxleyi* (Lankester sp., 1865).

With further reference to the nomenclature of the fossil Walruses of the Pliocene deposits of Suffolk and Belgium, in the splendidly illustrated memoir of the fossil remains of marine Carnivora obtained from the environs of Antwerp, Prof. van Beneden describes* various bones of Walrus-like animals under two genera, viz. *Trichecodon* and *Alachtherium*. Without discussing the value of the generic characters, Prof. Lankester, nevertheless, points out that Vicomte du Bus † had previously proposed the name *Alachtherium*, and that *Trichecodon* had been preoccupied by himself (1865), *suprà*. In default of specimens showing both bones and tusks in juxtaposition, it is perfectly hopeless to attempt to identify either Prof. van Beneden's own fragment of a tusk or the Suffolk specimens with those bones which he calls *Alachtherium*, on the one hand, or with those which he calls *Trichecodon*, on the other. At the same time, should there really be only one Walrus-like animal proper to this period, neither *Alachtherium Cretesii* of Du Bus (1867), nor *Trichecodon Koninckii* of Van Beneden‡ (1871) have priority as its title, but *Trichecodon Huxleyi*, Lankester (1865).

The conclusion then arrived at by the author, from a careful consideration of Prof. van Beneden's statements in his large monograph (1877), and from that of his shorter memoir (1871),

* Annales du Musée Royale d'Histoire Naturelle de Belgique, tome i. (1877).

† Bulletin de l'Acad. Roy. Belg. 1867, p. 562.

‡ Bull. de l'Acad. Roy. Belg. 2e sér. tom. xxxii. p. 164.

and of Du Bus's account of *Alachtherium* (1867), is :—that there is no evidence for the association of the tusks of *Trichechus* (*Trichecodon*) *Huxleyi* of Suffolk with any one set of the bones of Walrus discovered at Antwerp rather than with any other; and inasmuch as the tusks which we now possess furnish as sound a basis for generic and specific characterization as do detached and fragmentary bones of the general skeleton, the title *Trichechus Huxleyi* should hold its place. Whilst further, if the generic term "*Trichecodon*" is to be used at all, it is applicable, not to bones which give no specific information relative to the teeth, but to the teeth themselves in the sense in which Prof. Lankester made use of it fifteen years ago at Prof. van Beneden's suggestion.

Having disposed of the question of nomenclature, Prof. Lankester proceeds to describe the fine set of large tusks of *Trichechus* (*Trichecodon*) *Huxleyi* from the Suffolk Crag, which are deposited in the Ipswich Museum. These he compares with those of the recent form of Walrus (*Trichechus rosmarus*) in the College of Surgeons Museum; and he draws certain conclusions therefrom as to absolute size, sectional diameter, curvature, fluting, and attrition of tusks at different ages and in the two sexes. He finds that in the recent and fossil canines of the Walrus there is a precisely parallel variation. He recognizes four kinds of differences of form resultant from age and sex :—1. Small tusks, almost straight, with unworn points and large pulp-cavity: these belong to young individuals. 2. Full-sized tusks, more slender and curved and with less pronounced fluting and ridges than in no. 3: these appear to belong to females. 3. Full-sized tusks not longer than the last, but less curved and more massive, and having a greater transverse diameter and a more marked grooving and ridging of the flattened sides of the tusk. 4. Short massive tusks with the pulp-cavity filled by osteodentine: these are worn-down tusks of old individuals, and exhibit a difference in girth accordingly as they have belonged to male or female.

With regard to curvature, maximum size, and fluting of the Crag Walrus as compared with the living form, while there is a certain agreement between them, the former (*T. Huxleyi*) are distinguished by their greater size and curvature, their relative lateral compression (the recent tusks of *T. rosmarus* having a more circular contour), and a some what deeper and more constant longitudinal fluting.

In an appendix the author reasons concerning the conditions of

growth and attrition of the Walrus-tusks. He observes that growth does not necessarily proceed *pari passu* with attrition, and consequently tusks of the same age may be of various lengths; the biggest tusks, *cæteris paribus*, will be those which have suffered least rubbing during the process of growth. The causes of attrition are not merely due to friction of the points upon ice studded with sand particles, but rather to the digging up of the sea-bottom when the Walrus is in search of mollusca, or when scraping rock-surfaces to detach limpets and such like. As regards the sea-bottom and shore, it is hardly possible to doubt that the Miocene (Diestien) sea, with its *Pyrula*, *Voluta*, *Cassidaria*, *Pholadomya*, and such forms, and its Teuthophagous whales (*Ziphioids*) and its huge sharks, *was not* an ice-bound sea. The Walrus' tusks, then, are only secondarily, and not primarily, related to its movements upon shore-ice. With no very hard rocks against which to wear down its tusks, the Diestien Walrus accordingly had them longer, of greater primitive curvature, and a greater lateral compression, as compared with the Walrus now inhabiting the seas of the northern regions.

On the Specific Identity of *Scomber punctatus*, Couch, with *S. scomber*, Linn. By Francis Day, F.L.S.

[Read June 3, 1880.]

(Plate VII.)

In the 'Zoologist' for 1849, Mr. Couch described a Mackerel, which he had obtained the previous year in Cornwall, as "the Dotted Mackerel," *Scomber punctatus*. Prior to that period it had not been observed, while since that time it has remained unrecognized until April 21st this year, when I received a specimen from Mr. Dunn, of Mevagissey, in Cornwall, where it had been taken the previous day. I was exceedingly gratified at obtaining this specimen (which was uninjured and quite fresh), as I particularly wished to examine some of the species of British fish which are least known and merely doubtfully admitted to the rank of species. Pennant, 'British Zoology,' ed. 1776, and Fleming, 'British Vertebrates,' merely record the "Common Mackerel" (*S. scomber*) as existing in the British seas. Turton, 'British

Fauna' (1807), adds the "Spanish Mackerel" (*S. colias*) which is likewise included by Jenyns, 'British Vertebrate Animals' (1835), Yarrell, 'History of British Fishes' (editions 1836 and 1841), White, 'Catalogue of British Fishes (1851),' and Thompson, 'Natural History of Ireland (1856)—the last three authors considering *S. maculatus*, Couch (Mag. Nat. Hist. v. p. 832), as a synonym of *S. colias*. Sir John Richardson, in the 3rd edition of Yarrell's 'British Fishes,' included *S. punctatus*, Couch, as a distinct species, observing, at the same time, that, "as no second example has yet been met with, and the chief peculiarities in the Dotted Mackerel are its colours and markings, its specific rank may remain a question until the acquisition of other specimens furnish the means of investigating its internal structure." Dr. Günther, 'Catalogue of the Fishes of the British Museum,' 1860, places the *S. punctatus* among the doubtful species upon which no opinion is offered; while *S. scriptus*, Couch, which may prove to be merely another variety of the Common Mackerel, had not been described at that period.

Couch's example of the Dotted Mackerel (*S. punctatus*) was a female, 15·5 inches in length, captured in a mackerel-seine at Looe, in Cornwall, July 6th, 1848. It was erroneously said to possess an air-bladder, which, however, Couch, in his 'Fishes of the British Islands' (1863), observes was a mistake of Sir John Richardson's, the specimen having been "destitute of a swimming-bladder." He considered that it differed from the common Mackerel in that there "were scales which covered the surface of the sides and belly, where none at all appear in the common species." The example of the common species under that author's eye at the time appears to have been thickly covered with mucus; as in the specimens I have examined scales were present "on the sides and belly;" consequently, in this respect, no difference exists between the two forms. Next Couch draws attention to the length of the interspace between the dorsal fins in the two forms; but if a pair of proportional compasses is employed, it will be found that distance is identical in the two figures given in the 'History of the Fishes of the British Isles.' In short, Couch justly concludes that "the most remarkable distinction between this and the other British species of Mackerel was in the colour, which was of an uniform dark neutral tint over the head and back, without any bands or variegations; it might be termed an olive bluish-green, with green reflections at the sides; and from before

the eyes, along the back and sides to the tail, the surface was thickly covered with (black) spots of the size of a small pea, generally round and well defined, but a little larger, and elongated transversely on the summit of the back. The spots ended a little below the lateral line, and the belly was pure white; the surface between the carinations of the tail a bronzed yellow colour." Certainly if the description of the colours had been taken from the specimen I am recording, it could hardly have been more accurate; while, as it is, by such, or markings alone, that the distinction can be shown between the "Dotted" and the "Common" Mackerel, it must be conceded that the example here figured (Pl. VII.) represents the former variety.

D. 13 | $\frac{1}{11}$+v. P. 21. V. 1/5. A. 1 | $\frac{1}{11}$+v. C. 17.

Extreme length 14, to base of caudal fin 12·75, of each caudal lobe 2·25, of head 3·2 inches. Dorsal fin, length of base 2 inches, of second spine 1·3, of interspace between two dorsal fins 2·3, of base of second dorsal 1·0, of base of anal fin 1·1, length of pectoral fin 1·5. Lower jaw very slightly the longer. Eyes, diameter one fourth of the length of the head, $1\frac{1}{4}$ diameter from the end of the snout and 1 apart. The posterior extremity of the maxilla reaches to beneath the middle of the eye. Air-bladder absent. Length of intestines from pylorus to vent 10·5 inches. The example was a female, and the ova not quite mature. The number of its fin-rays, and even scales, as well as its proportions, agree so well with some British examples of *S. scomber*, that further description appears to be unnecessary, except to remark that the interorbital space is slightly broader in this specimen than some of the Common Mackerel; but I find such liable to individual variations.

The European forms of Mackerel may be subdivided, for the sake of convenience, into (1) those possessing an air-bladder and (2) those in which this organ is deficient. They are as follows:—*Scomber pneumatophorus*, which extends from the Mediterranean southwards, and *S. colias*, also a Mediterranean form, but visiting the British isles, have both an air-bladder; consequently the "Dotted Mackerel" cannot be a variety of either of those species. *S. scomber*, however, has no air-bladder, and is (excepting in colour) identical with the form under review, while it yet remains to ascertain whether the "Scribbled Mackerel," also destitute of an air-bladder, is not merely another variation in colour of the same species. Respect-

ing the variety placed by Couch in plate lxxx. below the "Spanish Mackerel" (*S. scriptus*), but which he observes that he "supposes it to be a different species," it seems to be another variety in colour of the common form, in which the first dorsal fin is a little more forward and the second spine is slightly higher, if such is not an error in the figure. He also observes that this variety "has no air-bladder;" and likewise expressed his belief (p. 82) that none is present in *S. colias*, although such has been described in Cuvier and Valenciennes's 'Histoire Naturelle des Poissons,' 1831, viii. p. 47; but not believing in its existence, Couch appears to have fallen into an error.

On two Cases of Incorporation by Sponges of Spicules foreign to them. By Stuart O. Ridley, F.L.S., Assistant in the Zoological Department, British Museum.

[Read June 17, 1880.]

Two cases of this phenomenon, to the common occurrence of which Mr. Carter has already called attention*, have recently come to my notice while working out some Sponges from the southern hemisphere, and they seem to me to be of some interest. The one is that of a specimen assigned to the genus *Ciocalypta*, Bowerbank, in which the dermis would be almost naked (a very unusual character) but for the occurrence in it of certain long acuate spicules having a very slight elongated basal inflation or head. They are found scattered through the membrane, singly or in loose bundles. The superior ends of the main skeleton-fibres themselves reach the dermal surface, and there spread out like the branches of the date-palm; but they do not extend across the surface to the same amount as in *Ciocalypta penicillus* and *C. Leei*, Bowerbank; for here they do not meet their fellows to form the lattice-like surface meshwork which is so conspicuous a feature of those species. It is therefore in the vacant spaces left between the freely-terminating ends of the skeleton-fibres that the subcapitate acuate spicules above mentioned are found. They measure from ·426 to ·468 millim. in average greatest length by ·011 to ·01267 in thickness; they taper gradually to a fine point, and the head, which is only plainly discernible under a high power

* Ann. N. H. (4) xvi. pp. 11, 16, xviii. pp. 230, 232. *Cf.* also *Id. op. cit.* (5) ii. p. 358.

of the microscope, is of a very elongated oval shape, sometimes of irregular outline; the spicule diminishes in diameter just below the head, which is of about the same diameter as the thickest part of the shaft, although, from its superiority in size to the "neck," this is not at first evident. Had the spicule not been of so interesting a type, it might perhaps have been set down as the proper dermal spicule, as "occurring irregularly scattered or fasciculated," especially as a special dermal spicule is wanting, and the dermis presents otherwise an unusually bare appearance. Also the characters of the skeleton-spicule of the sponge would rather lead one to believe the dermal form to be merely one slightly altered, owing to position, from its type, as its relative shortness (a character commonly distinguishing dermal and skeleton spicules), identical thickness, and similar shape would lead one to conclude. The skeleton-spicule is acuate, slightly bent, sharply pointed, with a well-rounded basal end, without inflation, size ·577 by ·01267 millim.

However, a reference to sketches of the spiculation of another sponge, an *Esperia*, from exactly the same locality, and obtained, as its association in the same vessel with the *Ciocalypta* would seem to show, at the same haul of the dredge, demonstrated an identity in form between this spicule and the one which forms the main skeleton and the dermal network of that sponge. As the drawings were not both made to scale, measurement was necessary to satisfy the doubt as to the possible common origin of the two spicules, with the result that the main skeleton-spicule of this second was found to measure ·544 by ·01267 millim.; while the average largest size of the dermal spicules, which agree precisely with the skeleton-forms as to shape and proportion, is ·468 by ·01267, just the size, as will be seen by comparison with the measurements given above for the spicule from the dermis of the *Ciocalypta*, of the largest of those there discovered. The inference is unavoidable, that the latter sponge has adorned and strengthened its dermis with elements derived from the dermis of the *Esperia*, which probably grew close by, and which, from the friable character of its surface, even in the spirit-specimen which we possess, probably frequently lost its surface-spicules either by attrition against tide-borne objects or by their natural shedding in the course of growth. The former hypothesis is not an impossible solution, for the depth at which the sponges grew was only 7–10 fathoms. Of their being lost by natural shedding, I know

no analogous facts in confirmation, the evidence rather tending to show that as growth continues the surface-spicules, if of the same kind as those of the main skeleton, become incorporated with it either by adhesion to the perpendicular (primary) lines or by remaining horizontal to form the latest-formed "secondary lines"; at any rate, the appearances seen in perpendicular sections of some of the regular *Isodictya* seem to point to this conclusion.

The other instance is that of *Alebion* (Gray) sp., and needs no special detailed account, as the circumstance of occurrence of the foreign spicules is essentially the same. It is also the same spicule (measuring here slightly less, ·45 by ·01056 to ·01108 millim.) which is the intruder. It occurs scattered or in bundles in the dermis. The sponge is also from the same locality and depth as the *Esperia* above mentioned; but, unfortunately, the number of the jar in which it arrived is not preserved, so that it cannot be presumed with such probability that it is from the same haul of the dredge.

It only remains to draw the attention of workers at sponges to these two cases, by way of warning against being misled by spicules occurring chiefly in the dermis of sponges, which are not so universally distributed there as to lead to the conclusion that they belong to the sponge, even though, as in this case, the fine preservation of the spicule and absence of enlargement of the central canal would not suggest their being foreign to it. Sometimes this may be seen at a glance, as when an obviously calcareous triradiate spicule is found in a sponge whose complement is made up (*e. g.*) of siliceous acerates, or when an unmistakable *Geodia*-ball occurs under similar circumstances. But the present is one which differs essentially from such cases; the spicules are well preserved, present some degree of regular arrangement, and are not radically distinct from the type which would be expected in the sponge. Still the difference of form and the manner of occurrence are sufficient to point out their foreign origin in this case; and if, as is far the most usual, they had been broken, or their central canals were enlarged by absorption, or the heads had projected outwards and the points inwards, these, which are the safest proofs of the foreign origin of a spicule, would have infallibly guided to a correct judgment as to their nature.

On supposed Stridulating-Organs of *Steatoda guttata*, Wider., and *Linyphia tenebricola*, Wider. By F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.

[Read June 17, 1880.]

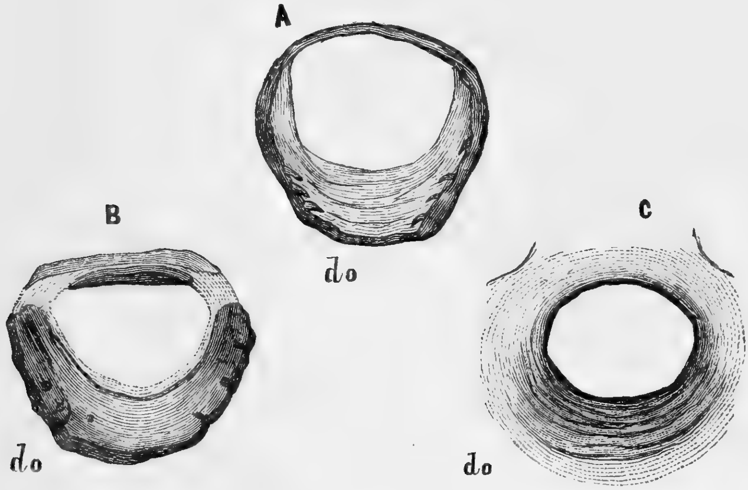
Professor Westring (Naturhist. Tidsskrift, vol. iv. 1842–44, p. 359, and vol. ii. 1846–1849, p. 342, and 'Araneæ Suecicæ') discovered stridulating-organs in the following Spiders, viz.:—*Assagena phalerata*, Panz., *Theridion hamatum*, C. Koch, *Steatoda bipunctata*, Linn., *S. castanea*, Clk., *S. albomaculata*, De Géer, and *S. guttata*, Wider. In 'Araneæ Suecicæ' (1862) Prof. Westring writes of the *Assagena phalerata* (p. 175) "Femina organis iis caret;" but does not mention the female of the other species as *not* possessing the stridulating-apparatus. Throughout, however, he refers only to its presence in males, as when speaking of the male *Steatoda bipunctata*, he adds:—"hic sexus similiter ac ♂ *Th. serratipedis*, *hamati*, *castanei*, *guttati* et *albomaculati* stridere potest. Mas descriptus post captivitatem minus libenter sonum reddit, quare, si hunc audire velles, animalculum statim ut capitur inter digitos ad aures est tenendum" *. Mr. Darwin ('Descent of Man,' 2nd ed. p. 273) and Professor Wood-Mason (Trans. Ent. Soc. 1877, p. 282), apparently quoting Westring, state that the apparatus consists "of a serrated ridge at the base of the abdomen, against which the hard hinder part of the thorax is rubbed; and of this structure not a trace could be found in the females." The Rev. O. P. Cambridge ('Spiders of Dorset,' vol. i.) refers to these organs as a distinction of species in *Assagena phalerata*, Panz., *Steatoda bipunctata*, Linn., *S. guttata*, Wider., and *S. sticta*, Cambr. He describes certain of them as possessing, in "the fore extremity of the abdomen, a sort of socket, serrated or denticulated on its upper edge; and into this the hinder extremity of the cephalothorax fits."

I am indebted to the last-named araneologist for specimens of male and female of *Steatoda guttata*, Wider., and *S. bipunctata*, Linn. In the male of the former the socket is a complete ring with some strong chitinous spurs on the inside of its external edge (fig. 1, A), which is also roughly serrated. That of the female is divided into two parts, the inferior being the smallest, while the superior, as in the male, is the deepest. In the female

* I have had no experience of this.

(fig. 1, B) there are no spurs; the inner edge, however, is undulated, and in points becomes angulated, while a little below are stiff hairs on small protuberances. The chitinous thoracic extension of the male is marked on its superior surface with many fine parallel transverse grooves, which are absent in the female (fig. 1, C); while in the same position on both sexes are several

Fig. 1.



Stridulating-organs of *Steatoda* (*Theridion*) *guttata*, ♂ and ♀.

A. Male. View, from above, of chitinous ring or socket attached to abdomen covering the union with thorax. *do*, dorsal surface.

B. Ditto of the female. *do*, dorsal surface.

C. View, from above, of chitinous extension of thorax; female. *do*, dorsal surface.

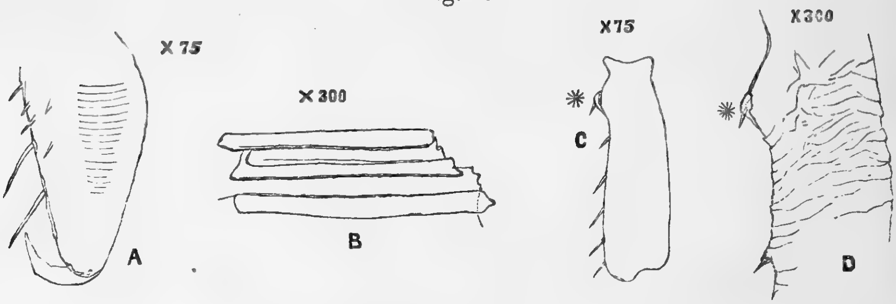
ridges, which are less numerous in the male. It is quite likely that individuals may vary in details; but it appears that the female of *Steatoda guttata*, Wider., has, as well as the male, organs adapted to stridulation.

I have also examined both sexes of *Steatoda bipunctata*, Linn., and find that the socket of the male is much shallower than those of the male and female of the last-named species. The inside of the external edge is rough, and the sides are lined with a row of bristles seated on prominences; and the only opposing surface is a spinate ridge on the base of the thorax, which has no chitinous extension covering the abdominal union. In the female there is no trace of these organs.

In the same paper already quoted (Trans. Ent. Soc. 1877, *Mygale stridulans*), Prof. Wood-Mason describes the totally different sound-producing apparatus in male and female of "*Mygale stridulans*" of Assam, "on the inner face of the basal joint of the

palps" and "the penultimate joint of the chelicerae." The organs which I venture to call stridulating in both sexes of *Linyphia tenebricola*, Wider. (=*Linyphia terricola*, Blackw.,=*Linyphia tenuis*, Blackw.†), are also seated on the falces and palpi, but are of different structure. I observed them while examining the palpal organs with a $\frac{3}{4}$ objective, and defined them with higher powers as follows:—On the outer side of the basal joint of each falx are about twenty parallel transverse chitinous bands, placed so that their inferior edges are free (fig. 2, A), as is easily seen in section (fig. 2, B). The effect, when viewed from the front, is that each falx has a distinctly serrated outer edge, which becomes more decided towards the base. The opposing surface is that of the humeral joint of each palpus, which is marked with a more or less regular series of curved grooves, deep enough to give the appearance of serration on its sides under a $\frac{2}{3}$ objective. On the inside of this joint close to its base is a curved enlargement, and on the top a prominent, horny, somewhat triangular, knob-like plate (fig. 2, C* and D*) with a rounded apex. This differs in form, size, elevation, and position from the chitinous prominences usually seen in connexion with spines, of which there is one near its side, but of which in some individuals it is independent.

Fig. 2.



Stridulating-organs of *Linyphia tenebricola*, Wider., ♂.

A. Right falx as viewed obliquely from the right side.

B. Part of three stridulating-bands. The broken edge is to the reader's right.

C. Humeral joint of left palpus, the spines being omitted, except those on the inside. * Horny plate.

D. Basal portion of third joint, showing at * the horny plate.

These organs persist in all adult members of both sexes of this species; but those on the palpi of the females are not so highly developed, the chief difference being the size of the enlarge-

† See Thorell, 'Remarks on Synonyms of European Spiders,' p. 66; and Cambridge, 'Spiders of Dorset.'

ment at the base of the third joint. When confined in a small glass tube, these Spiders often move their palpi backwards and forwards with a slight rotatory motion in such a manner that the horny plate crosses the bands on the falces; but hitherto I have been unable, even with the aid of a microphone, to detect sounds in connexion with these movements.

The bands appear to be a modification of grooves which are to be found on the falces, and which are similar to those already mentioned on the palpi, and are also present, without any specialized form, on the falces of *Linyphia clathrata*, Lund, whose habits resemble those of the *L. tenebricola*, Wider. They are sufficient to give an appearance of slight serration; but up to the present I have been unable to find any opposing surface which could be used for stridulation in *Linyphia clathrata.*

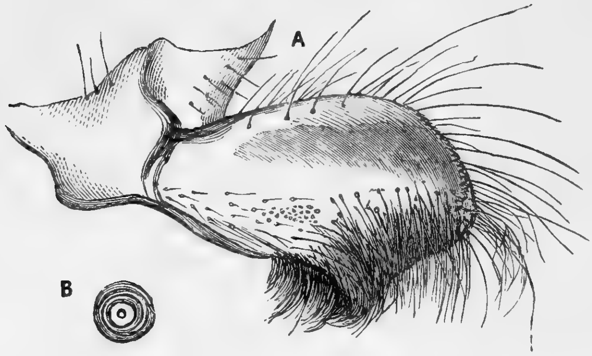
The absence of specialized stridulating-organs in most Araneæ does not, however, imply that they are mute. It is a common practice with many to rub the falces against the maxillæ; and were the serrated edge of these latter found in another part of the body, similarly opposed to a hard toothed chitinous surface, it is most likely they would be pronounced stridulating-organs.

On certain Glands in the Maxillæ of *Tegenaria domestica*, Blackwall. By F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.

[Read June 17, 1880.]

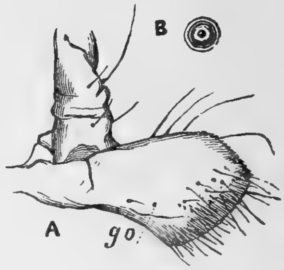
Dr. A. Wassmann, in "Beiträge zur Anatomie der Spinnen" (Abhandl. aus dem Geb. der naturwiss. Hamburg, Erster Band, 1846), and M. Felix Plateau, in his "Recherches sur la Structure de l'appareil digestif, et sur les Phénomènes de la Digestion chez les Aranéides dipneumones" (Bull. Acad. Roy. de Belgique, sér. 2, t. xliv. 1877), describe a gland which is seated in the labrum; but they, like all other writers to whom I have referred, make no mention of those which I am about to describe. In the *Tegenaria domestica* the apertures are on the inner side of the median line of the upper face of each maxilla, where they commence to incline towards the mouth, as seen in woodcuts figs. 1 and 2, A. The external form consists of a ring (figs. 1 and 2, B), ·005 millim. in diameter (average outside measurement) in adults, enclosing a raised disk, in the centre of which is the opening leading to a shallow cavity, from which runs the

Fig. 1.



A. Upperside of left maxilla of *Tegenaria domestica*, Blackw., immature ♀, ×40. B. One of the gland-openings, ×770.

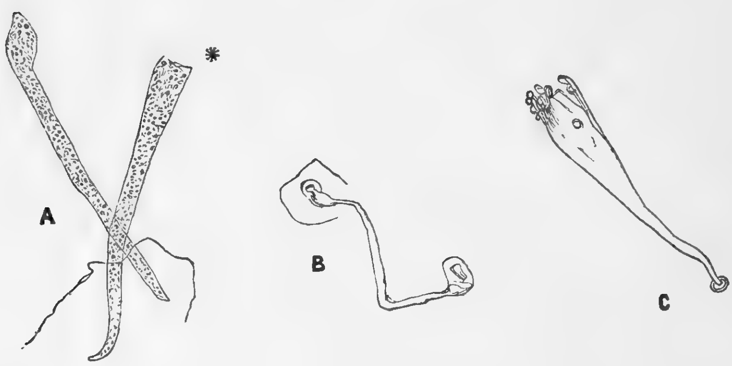
Fig. 2.



A. Upperside of maxilla of *Tegenaria domestica* from the first exuvium: *go*, gland-opening, ×66. B, single gland-opening on above, ×770.

duct, gradually increasing in size, until it terminates in an elongated bulbous point (fig. 3, A). I have been unable to trace any further continuation of the organ; but in a *Lycosa campestris*, Blackw., where the apertures are of similar form and position, I have found fine filaments, as shown in fig. 3, C, while in some species the ducts are ramose.

Fig. 3.



A. Gland from maxilla of *Tegenaria domestica* attached to inner skin. That marked with an asterisk (*) has its terminal point broken. × 250.

B. Chitined-gland attached to maxilla of *Ciniflo ferox*, Blackw., and, as here shown, is foreshortened. × 250.

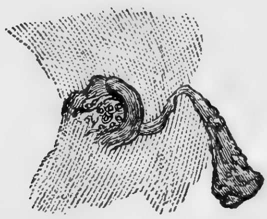
C. Chitined-gland from maxilla of *Lycosa campestris*. ×250.

The surface on which the glands discharge their contents is crossed by many interlacing open channels formed by folds in the integument (see fig. 5, E), and which run backwards and down-

wards towards the mouth. I am inclined to think that these glands have a function equivalent to salivary; and in many species of the Linyphiidæ, Theridiidæ, Salticidæ, and Epeiridæ there are similar organs, but distributed at the side of the maxillæ close to the mouth in a cup-like cavity, as seen in the accompanying fig. 4, from an *Epeira similis*, Blackw.

A peculiarity of the ducts is that in many species they become chitinous (fig. 4); and this is common in adults, so that it cannot be considered the result of a condition preceding a moult.

Fig. 4.



Chitinous gland-opening on maxilla of *Epeira similis* (♂), as seen from outside of maxilla, with one chitined-gland attached, × 200.

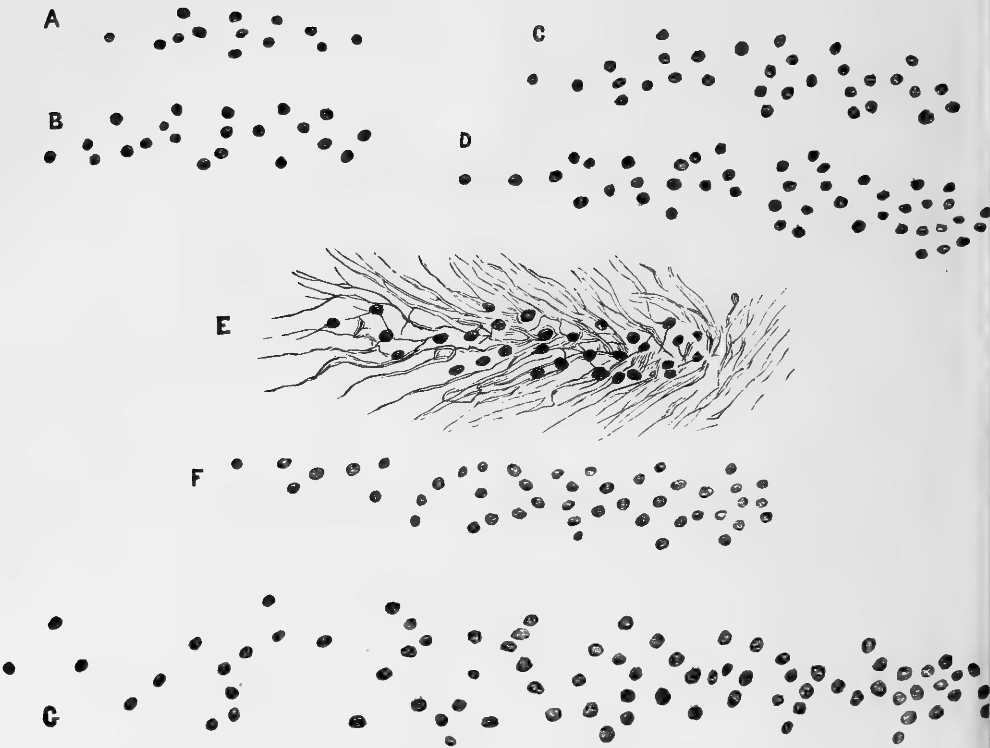
In the *Tegenaria domestica*, Blackw., and also in other species, the number of these glands, together with the integumental channels, increases with age. I found only one aperture on each maxilla of the first exuvium of ten of this species and two on the second. A young one which last year I kept in confinement gave the following results, viz.:—

Date of exuvium, 1879.		Number of gland-openings.
15th May	Woodcut fig. 5, A	13
9th June	,, B	21
1st August	,, C	31
21st September ...	,, D	46

In the diagrammatic woodcut (fig. 5, C, D, E, and F) the relative positions on each exuvium are indicated; and it will be seen that the number on each maxilla is the same, though the distribution is not. Unfortunately this Spider was allowed to escape in December, so that I cannot give more figures; but fig. 5, G, represents eighty gland-openings on an adult *Tegenaria domestica* (female), while in others I have found as few as sixty.

These remarks are the result of an investigation which was

Fig. 5.



Diagrams representing the gland-openings on the maxilla of *Tegenaria domestica* at different stages; about × 200.

A. As in the exuvium of right maxilla, 15th May. B. Ditto, 9th June. C. Ditto, 1st August. D. Ditto, 21st September. E. As in the exuvium of left maxilla, 1st August: the integumentary channels are here shown. F. As in exuvium of 21st September. G. Gland-openings in an adult female of *T. domestica.*

necessarily prolonged, owing to the continual rupture of the duct and terminal portion of the glands on opening the maxillæ. I first observed the external organs with a $\frac{2}{3}$ objective, and think that the reason why they have hitherto escaped notice is that under such a low power they appear like simple rings, and resemble the integumental structure at the base of some minute setæ distributed about the same surface. Even with a $\frac{1}{5}$ and $\frac{1}{10}$ this definition might at first be confirmed, and the form of the raised disk attributed to the approximate focusing of different points in an attached open duct. By using the bleaching process described by Dr. Braxton Hicks (Linn. Trans. 1st ser. vol. xxii. p. 396) and mounting in balsam, the form of the external organ, however, is clearly seen with a $\frac{1}{5}$ objective.

Notes on *Aplysia dactylomela*.

By G. E. Dobson, M.A., M.B., F.L.S., &c.

[Read June 17, 1880.]

The specimen which forms the subject of the following notes was obtained by Mr. R. Vacy Ash, M.B., Surgeon, Army Medical Department, in February last, at Bermuda. It agrees so closely in size, and in the coloration and shape of the body and shell, with the figures and description given by Rang of his *Aplysia dactylomela**, from the Cape-Verd Islands, that I have little hesitation in recognizing it as an example of that species, though from the opposite side of the Atlantic.

The specimen in question was found in shallow water inside the reef fringing the island, and was seen through the clear water moving along on the bottom, the lateral swimming-lobes keeping up a gentle undulatory motion. Mr. Ash describes its colour as a rich drab, marked all over with circles and streaks of velvet-black, the latter most abundant on the mantle covering the shell and on the lateral swimming-lobes. The shell agrees in all respects with that of *A. dactylomela* as figured by Rang, and the only difference observable is that the margins of the swimming-lobes are not tinged with violet. This might be accounted for by supposing that such a fugitive colour had disappeared in the alcohol, but the captor does not remember to have seen it in the living animal.

The following points appear not to have been previously noted:—

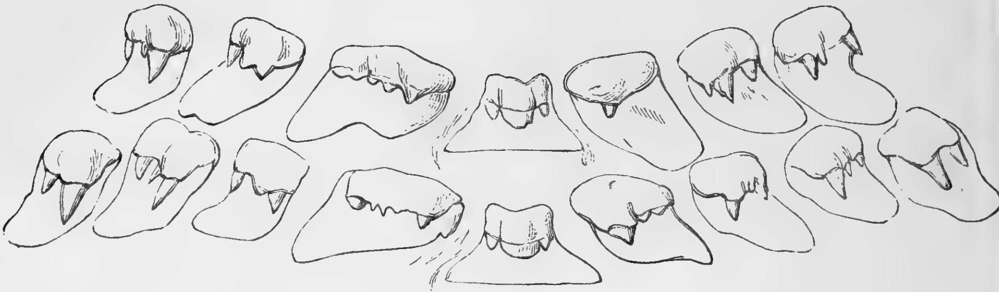
The lingual ribbon is nearly as wide as long, and supports about 75 rows of recurved teeth, having the formula 43–1–43, representing the number in a row taken at the widest part.

In fig. 1, where portions of two tooth-rows from the centre of the lingual ribbon are shown, the median or rhachidian tooth is smaller than the lateral teeth, and has a blunt central cusp with two small lateral cusps. The bluntness of the central cusp may, however, be due to wear, although throughout the 75 rows this cusp presents the same character. It may also be observed that the first teeth to left and right of the median tooth are not symmetrically developed, the left tooth being much larger

* Rang, 'Histoire Naturelle des Aplysiens,' p. 56, pl. ix. (1828).

than the right; and this inequality is continued throughout the series*.

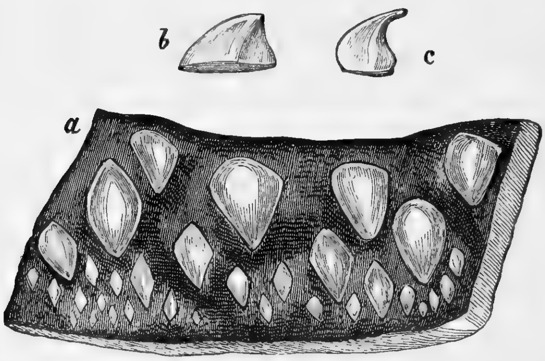
Fig. 1.



Lingual teeth of *Aplysia dactylomela*, × 58 diam.

The mandibles, or labial plates, are invested internally with a rough leathery substance, which, as seen by a $\frac{1}{4}$ objective, consists of indurated cylindrical rod-like bodies, imbricated, with rounded extremities, forming a depressed pile, very similar to the corresponding structure in *Triton*.

Fig. 2.



Gizzard of *A. dactylomela* cut open, showing position and relative sizes of spines (natural size).

The gizzard is armed with about thirty-three horny tooth-like spines, the arrangement of which is shown in fig. 2, *a*, above, where the position of their bases is indicated. The leading forms of these spines are shown at *b* and *c*, where two of the largest are figured of the natural size. The very capacious stomach of the animal was found to be filled with undigested food, consisting chiefly of a minute species of Algæ.

* As in other species of Gasteropoda, an abnormality occurring in one of the lingual teeth is repeated in the longitudinal series to which it belongs.

On the Natural Classification of Gasteropoda.—Part I.

By Dr. J. D. Macdonald, R.N., F.R.S.

[Read June 17, 1880.]

In the year 1860, just twenty years ago, Professor Huxley communicated to this Society a paper of mine, on the "Classification of the Gasteropoda," founded respectively, 1st, on the sexual characters, 2nd, on the lingual dentition, and 3rd, on the auditory concretions; and, notwithstanding all that has been done of late years in this department of natural history, the General Table then given would still appear to hold its ground as a natural arrangement.

The object of this paper is to add some additional remarks and suggestions to the former one, adopting a fourth guide to the discovery of natural affinities, namely, "*Representative Relationships.*"

The faculty of comparison should be well developed in the systematic naturalist; but we often find that it is misapplied, and superficial resemblances are assumed to be indications of genuine affinity, so that, apparently, like things are grouped together, though intrinsically bearing no natural alliance to each other. Indeed, underlying nearly all the mistakes that have been made in matters of classification, we find the occurrence of representative relationships or analogous characteristics repeating themselves in particular members of the orders, suborders, families, or even smaller groups of the Animal Kingdom. The recognition of such representative relationships, as distinguished from those of affinity, must depend upon a more general comparison of structure. Thus, breathing in air, for instance, can be easily shown to be a representative character amongst larger groups, and, of course, of great importance in neighbouring species; but it can by no means warrant the association of the members of two otherwise quite distinct groups. Yet, if we analyze the *Pulmonifera* of authors, what do we find? First, that all air-breathers are placed in one category; secondly, that they are recognized to be either *operculate* or *inoperculate*; and, thirdly, that the momentous question of being *monœcious* or *diœcious* is either not noticed at all, or referred to in a casual way, the latter being indicated by the presence and the former by the absence of an operculum—though, unfortunately, some *Diplommatinæ*, which are unisexual, are inoperculate, and the anomalous bisexual genus *Amphibola* is furnished with an operculum.

If we now turn to the analogy of shell-characters in a general way we find :—

1st. That some Gasteropodous families are altogether naked, having no representatives furnished with a shell.

2nd. That some have both naked and shell-bearing species.

3rd. That others are all furnished with a shell, having no naked representatives.

Under the first head would come the Nudibranchiata of authors, and the second would include the Tectibranchiata, the bisexual Pulmonifera, and the Heteropoda; while the third would comprise all the remaining families. But for the position here given to the Heteropoda, this arrangement would seem to answer very well. If, however, we take a formula derived from the above heads and apply it to the second division, some interesting results will be obtained. Referring to the Heteropoda, first, by way of illustration, we find six typical genera ; two of these are entirely naked, namely *Firola* and *Cerophora* ; two others have a shell of only sufficient size to protect the viscera, viz. *Cardiapoda* and *Carinaria* ; while the two remaining genera have an operculate shell, completely including the retracted animal, *Oxygyrus* and *Atlanta*. On attempting to arrange the shells we see that those of *Cardiapoda* and *Oxygyrus* are cartilaginous with an involute nucleus, while those of *Carinaria* and *Atlanta* are hard and vitreous-looking with a spiral nucleus. Two distinct groups are thus clearly indicated.

First Group.

Shell ...	absent	....	*Cerophora.*
	present (cartilaginous, involute)	protecting the viscera	*Cardiapoda.*
		operculate, including the retracted animal	*Oxygyrus.*

Second Group.

Shell ...	absent	....	*Firola.*
	present (calcareous, spiral)	protecting the viscera	*Carinaria.*
		operculate, including the retracted animal	*Atlanta.*

It might be asked, why *Firola* should be placed with *Carinaria* and *Cerophora* with *Cardiapoda.* But the only reason that need be given is, that the general appearance of the animals and the comparison of their lingual dentition would appear to indicate the position assigned to them.

Many persons think that the Heteropoda should be separated from the Gasteropoda as a distinct class, but this would scarcely appear to be necessary. There is a much wider difference between

a *Bulla* and a *Strombus* than between the latter and an *Atlanta*, for example; and in reference to the genus *Phorus*, I find the following remarks in my note-book:—"The animal of *Phorus* is strikingly suggestive of *Atlanta* or *Oxygyrus*, and it has been remarked that the dentition closely resembles that of the Heteropod (Mörch). I am strongly inclined to think that the *Phoridæ* will be found to form the connecting link between the Gasteropoda proper and the Heteropods." To return to the subject from this digression, it will be easy to see that *Firola* and *Cerophora* are representatives in the two groups above given—that *Carinaria* represents *Cardiapoda*, and *Atlanta Oxygyrus*. Now if we deal with the monœcious Gasteropoda as a whole, we shall have the results as given in the following Table:—

Class **GASTEROPODA.**

Division I. MONŒCIA (sexes combined).

Subdivision I. *Lingual dentition typically pavemental* *.

Order I. Pneumonophora (lung-bearing, or respiring in air).

Suborder 1. Pulmonata (with air-chamber only).

A. Habit terrestrial.

Analogy of Shell-characters.				*Illustrative Genera.*
Shell ...	absent			*Janella.*
	present	internal		*Aneitiana*†.
		external	partial	*Omalonyx.*
			general or investing	*Succinea.*
Shell ...	absent			*Megimatium.*
	present	internal		*Limax.*
		external	partial	*Parmacella.*
			investing	*Helix.*
Shell ...	absent			*Philomycus.*
	present	internal		*Viquesnellia.*
		external	partial	*Daudebardia.*
			investing	*Vitrina.*

Suborder 2. Pulmobranchiata (having both an air-chamber and a ciliated surface or branchia for respiration in water).

B. Habit aquatic.

Shell ...	absent			——
	present	internal		——
		external	patelliform	*Ancyclus.*
			spiral	*Limnæa.*

* In some instances apparently strap-like, by reduction of the members of the *pleuræ*.

† A bitentaculate slug, occurring in N. S. Wales and the New Hebrides, described by me in Ann. & Mag. Nat. Hist. 1856, ser. 2, vol. xviii. p. 38.

C. Habit. Estuary and marine.

	Analogy of Shell-characters.				Illustrative Genera.
Shell ...	absent				*Oncidium.*
	present	internal			——
		external	patelliform		*Siphonaria.*
			spiral	inoperculate ...	*Auricula.*
				operculate	*Amphibola.*

Order II. Apneumonophora (having no air-chamber).

Suborder 1. Nudibranchiata.

All naked, having no representative with a shell ...	A. Cryptobranchiata	*Phyllirrhoë.* *Limapontia.* *Elysia.*
	B. Phanerobranchia	*Eolis.* *Tritonia.* *Doris.* *Phyllidia.* *Diphyllidia.*

Suborder 2. Tectibranchiata.

Shell (Pleurobranchidæ)...	absent			*Posterobranchæa.*
	present	internal		*Pleurobranchus.*
		external		*Umbrella.*
Shell (Aplysiadæ)......	absent			*Notarchus.*
	present	internal		*Aplysia.*
		external		*Icarus.*
Shell (Bullidæ)	absent			*Gasteropteron.*
	present	internal		*Philine.*
		external	Nucleus involute	*Bulla.*
(Tornatellidæ)			Nucleus spiral	*Aplustrum.* *Tornatella.*

Subdivision II. *Lingual membrane strap- or ribbon-like* *.

Order I. Heteroglossa. Teeth in five to eight longitudinal series, variable in form, the larger ones with opaque tips. Foot without any lateral fringe. Shell symmetrical.—*Gray.*

Suborder 1. Polyplacophora. Shells forming a linear imbricate series on the middle of the back.

Ex. *Chiton, Chitonellus,* &c.

Suborder 2. Cyclobranchia. Gill lamellar, forming a more or less complete ring beneath the mantle.

Ex. *Patella, Patina.*

Suborder 3. Cervicobranchia. Gill single, to the left on the back of the neck.

Ex. *Tectura, Gadina, Lepita.*

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* Dentition typically multiserial, with rhachis and pleuræ distinctly differentiated, the dental processes being recurved from the fore part of the basal plates (*anaclodontous*).

Suborder 4. CIRROBRANCHIA. Gills two, symmetrical, tufted on the back of the neck.

Ex. *Dentalium, Entalis.*

Order II. RAPHIDOGLOSSA. Teeth in numerous longitudinal series, the central 5 . 1 . 5, variable in form; lateral very numerous, more slender, curved at the tip. —*Gray.*

Suborder 5. DICRANOBRANCHIA. Gills two, symmetrical on the back of the neck.

Ex. *Deridobranchus* (a naked form), *Scutus, Emarginula, Puncturella, Fissurella.*

Suborder 6. SCHISMATOBRANCHIA. Gills in two plumes on the left side of the gill-cavity; body and shell spiral.

Ex. *Teinotis, Padollus, Haliotus, Scissurella.*

Suborder 7. SCUTIBRANCHIA. Gills in a spiral line on the left side; body, shell, and operculum spiral.

Ex. *Stomatella, Trochus, Turbo, Rotella, Nerita, Neritina,* and *Navicella.*

Suborder 8. PSEUDOBRANCHIA. Having no distinct gill, being in reality *pulmonate.*

Ex. *Helicina, Proserpina, Ceres.*

As to the propriety of the application of the term Pulmonata to the terrestrial monœcious Gasteropoda there need be no question; but to justify the use of the second subordinal term Pulmobranchiata the following reasons may be adduced.

1st. Siebold mentions that the raised vascular network of the lining of the pulmonary cavity is coated with cilia in the aquatic species, and he further says that he found ciliated epithelium in the pulmonary cavity of the *Limnæidæ*, though not in that of *Limax* or *Arion*. *Ancylus* was formerly placed in the Inferobranchia, though really having no alliance with them; and a simple, probably ciliated enlargement on the left side, concealed under a fold of the mantle, has been accepted and figured as a true branchia by both Treviranus and Vogt. S. Clessin thinks that the *Limnæidæ* normally respire water, though it should be remembered that water only finds access to the lung-chamber when the animals are very young, though the recorder of this fact (A. Pauly) is of opinion that this may be permanently the case with those species which habitually live in deep water.

2nd. In the amphibious genus *Oncidium*, Ehrenberg noticed the occurrence of more than twenty small ramified organs at the posterior part of the back, which he regarded as true branchiæ;

and I find that Jhering has observed the same structures in the genus *Peronia*, which lives between tide-marks, thus confirming Ehrenberg's view.

3rd. I can vouch myself for the coexistence of true branchiæ within the pulmonary chamber in both *Siphonaria* and *Amphibola*, having made drawings of them from the recent animals.

The branchial characters of the Nudibranchs have been so worked upon and variously represented by different writers, that I have only for the present made two sections of them. The first, or the Cryptobranchia, to include those forms which at best only present a ciliated surface for respiration; and the second, or Phanerobranchia, those in which the branchial organs are plainly discernible. Perhaps a much more satisfactory guide to classification will be found in the lingual and labial dentition, which, though exceedingly perplexing to the student, will, I am quite sure, be better understood when opportunities are more favourable for direct comparison and legitimate deduction.

There are, indeed, certain principles to be borne in mind when we enter upon the study of the dentition of a family or larger group exhibiting great diversity as to the number of the elementary parts and their particular form. The essential points to know are the following:—

The typical lingual dentition presents a central region, or *rhachis*, and two lateral parts, or *pleuræ* so-called. The dental organs are disposed in transverse rows succeeding one another from before backwards; and the lingual membrane upon which they are arranged is quite homogeneous and more or less corneous in consistency, supported by the lingual cartilages, and forming the floor and sides of the lingual sac, which latter usually projects downwards and backwards below the œsophagus from the floor of the mouth.

When the lingual membrane is comparatively short and broad and the teeth numerous and similar, the dentition assumes the form of a pavement; but, on the contrary, if the membrane is very much longer than it is broad, and there is a marked distinction between the rhachis and pleuræ, it acquires the character of a "ribbon" or "strap."

It is curious to remark, and it bears largely on the soundness of the primary division in the foregoing table of classification, that the *dentition is typically pavemental in the Monœcious and ribbon-like in the Diœcious Gasteropoda*; and, with certain exceptions, even admitting of explanation, the auditory sacs contain

otoconia in the former case and single spherical *otoliths* in the latter. The dental organs themselves usually consist of a basal plate of attachment, with which the dental tubercles or fangs, which always point backwards, are connected. They are subject to depreciation or suppression, and further development or increase, both wholly or as to their component parts, which has, no doubt, given rise to all the diversity of character which we observe in the different families of Gasteropoda. Thus we often find the dental processes so large as to quite absorb the basal plates, while in other cases the basal plate alone remains, as it were preparatory to its complete extinction. It will be seen therefore that if the pleura on each side gradually undergoes suppression, a typical pavement will be made to assume a more or less strap-like appearance; and this character will be made more deceptive by the coincident development of the rhachis*. On the other hand, if the rhachidian series is suppressed, the dentition will, of course, be divided into two lateral portions and thus become more or less decidedly double, the effect being enhanced by the greater development of the central part of each pleura. Illustrations of these conditions are to be found in all the principal sections of the Gasteropoda. I have only to regret at present that my time will not permit me to make this subject clearer by special reference to examples; but I hope to do so at some future period as an introduction to the second part of this paper, taking up the classification of the Gasteropoda Diœcia.

Observations on Ants, Bees, and Wasps; with a Description of a new Species of Honey-Ant.—Part VII. Ants.

By Sir John Lubbock, Bart., M.P., F.R.S., F.L.S., D.C.L., LL.D., Vice-Chancellor of the University of London.

[Read June 17, 1880.]

(Plate VIII.)

Power of Communication by something approaching to Language.

In my previous papers many experiments have been recorded, in which I have endeavoured to throw some light on the power of

* For example, in the Eolidæ and neighbouring genera, the affinity of which cannot be doubted, the gradual reduction from a typical pavemental dentition to the pseudo strap-like form may be easily observed.

communication possessed by ants. It is unquestionable that if an ant or a bee discovers a store of food her comrades soon flock to the treasures, although, as I have shown, this is by no means always the case. But it may be argued that this fact taken alone does not prove any power of communication at all. An ant observing a friend bringing food home, might infer, without being told, that by accompanying the friend on the return journey she might also participate in the good things. I have endeavoured to meet this argument in my third paper (Linn. Journ. vol. xii. p. 466) by showing that there was a marked difference in the result, if on experimenting with two ants one had access to a large treasure, the other only to a small one.

It also occurred to me that some light would be thrown on the question by compelling the ant who found the treasure to return empty-handed. If she took nothing home and yet others returned with her, this must be by some communication having passed. It would be a case in which precept was better than example.

I selected therefore a specimen of *Atta testaceo-pilosa*, belonging to a nest which I had brought back with me from Algeria. She was out hunting about six feet from home, and I placed before her a large dead bluebottle fly, which she at once began to drag to the nest. I then pinned the fly to a piece of cork, in a small box, so that no ant could see the fly until she had climbed up the side of the box. The ant struggled, of course in vain, to move the fly. She pulled first in one direction and then in another, but, finding her efforts fruitless, she at length started off back to the nest empty-handed. At this time there were no ants coming out of the nest. Probably there were some few others out hunting, but for at least a quarter of an hour no ant had left the nest. My ant entered the nest, but did not remain there; in less than a minute she emerged accompanied by seven friends. I never saw so many come out of that nest together before. In her excitement the first ant soon distanced her companions, who took the matter with much *sang froid*, and had all the appearance of having come out reluctantly, or as if they had been asleep and were only half awake. The first ant ran on ahead, going straight to the fly. The others followed slowly and with many meanderings; so slowly, indeed, that for twenty minutes the first ant was alone at the fly, trying in every way to move it. Finding this still impossible, she again returned to the nest, not chancing to meet

any of her friends by the way. Again she emerged in less than a minute with eight friends, and hurried on to the fly. They were even less energetic than the first party; and when they found they had lost sight of their guide, they one and all returned to the nest. In the meantime several of the first detachment had found the fly, and one of them succeeded in detaching a leg with which she returned in triumph to the nest, coming out again directly with four or five companions. These latter, with one exception, soon gave up the chase and returned to the nest. I do not think so much of this last case, because as the ant carried in a substantial piece of booty in the shape of the fly's leg, it is not surprising that her friends should some of them accompany her on her return; but surely the other two cases indicate a distinct power of communication.

Lest, however, it should be supposed that the result was accidental, I determined to try it again. Accordingly on the following day I put another large dead fly before an ant belonging to the same nest, pinning it to a piece of cork as before. After trying in vain for ten minutes to move the fly, my ant started off home. At that time I could only see two other ants of that species outside the nest. Yet in a few seconds, considerably less than a minute, she emerged with no less than twelve friends. As in the previous case, she ran on ahead, and they followed very slowly and by no means directly, taking, in fact, nearly half an hour to reach the fly. The first ant, after vainly labouring for about a quarter of an hour to move the fly, started off again to the nest. Meeting one of her friends on the way she talked with her a little, then continued towards the nest, but after going about a foot, changed her mind, and returned with her friend to the fly. After some minutes, during which two or three other ants came up, one of them detached a leg, which she carried off to the nest, coming out again almost immediately with six friends, one of whom, curiously enough, seemed to lead the way, tracing it, I presume, by scent. I then removed the pin, and they carried off the fly in triumph.

Again, on the 15th June, another ant belonging to the same nest had found a dead spider, about the same distance from the nest. I pinned down the spider as before. The ant did all in her power to move it; but after trying for twelve minutes, she went off to the nest. For a quarter of an hour no other ant had come out, but in some seconds she came out again with ten companions.

As in the preceding case, they followed very leisurely. She ran on ahead and worked at the spider for ten minutes; when, as none of her friends had arrived to her assistance, though they were wandering about evidently in search of something, she started back home again. In three quarters of a minute after entering the nest she reappeared, this time with fifteen friends, who came on somewhat more rapidly than the preceding batch, though still but slowly. By degrees, however, they all came up, and after most persevering efforts carried off the spider piecemeal. On the 7th July I tried the same experiment with a soldier of *Pheidole megacephala.* She pulled at the fly for no less than fifty minutes, after which she went to the nest and brought five friends exactly as the *Atta* had done.

In the same way, one afternoon at 6.20 I presented a slave of *Polyergus* with a dead fly pinned down. The result was quite different. My ant pulled at the fly for twenty-five minutes, when, as in the previous cases, she returned to the nest. There she remained four or or five minutes, and then came out again alone, returned to the fly, and again tried to carry it off. After working fruitlessly for between twenty and twenty-five minutes, she again went back to the nest, staying there four or five minutes, and then returning by herself to the fly once more. I then went away for an hour, but on my return found her still tugging at the fly by herself. One hour later again I looked, with the same result. Shortly afterwards another ant wandering about found the fly, but obviously, as it seemed to me, by accident.

Aug. 2. At 3 o'clock I put a dead fly pinned on to a bit of cork before a *Formica fusca,* which was out hunting. She tried in vain to carry it off, ran round and round, tugged in every direction, and at length at ten minutes to four she returned to the nest; very soon after she reappeared preceded by one and followed by two friends; these, however, failed to discover the fly, and after wandering about a little returned to the nest. She then set again to work alone, and in about forty minutes succeeded in cutting off the head of the fly, which she at once carried into the nest. In a little while she came out again, this time accompanied by five friends, which all found their way to the fly; one of these, having cut off the abdomen of the fly, took it into the nest, leaving three of her companions to bring in the remainder of their prey.

These experiments certainly seem to indicate the possession by ants of something approaching to language. It is impossible to

doubt that the friends were brought out by the first ant; and as she returned empty-handed to the nest, the others cannot have been induced to follow her merely by observing her proceedings. I conclude, therefore, that they possess the power of requesting their friends to come and help them.

Recognition of Relations.

In my last paper (Linn. Journ. vol. xiv. p. 611) I recorded some experiments made with pupæ, in order if possible to determine how ants recognized their nest companions. The general result was that pupæ tended by strangers of the same species, and then after they had arrived at maturity put into the nest from which these strangers had been taken, were invariably treated as interlopers and attacked. On the other hand, if they were tended by ants from their own nest, and then after arriving at maturity put back in their own nest, they were invariably recognized as friends; and, lastly, if as pupæ they were tended by strangers, but then after arriving at maturity put back in their own nest, they were generally received as friends. In all these experiments, however, the ants were taken from the nest as pupæ, and though I did not think the fact that they had passed their larval existence in the nest could affect the problem, still it might do so. I determined therefore to separate a nest before the young were born, or even the eggs laid, and then ascertain the result. Accordingly I took one of my nests, which I began watching on the 13th Sept., 1878, and which contained two queens, and on the 8th Feb., 1879, divided it into halves, which I will call A and B, so that there were approximately the same number of ants with a queen in each division. At this season, of course, the nest contained neither young nor even eggs. During April both queens began to lay eggs. On the 20th July I took a number of pupæ from each division and placed each lot in a separate glass, with two ants from the same division. On the 30th August I took four ants from the pupæ bred in B, and one from those in A (which were not quite so forward), and after marking them as usual with paint, put the B ants into nest A, and the A ant into nest B. They were received amicably and soon cleaned. Two, indeed, were once attacked for a few moments, but soon released. On the other hand, I put two strangers into nest A, but they were at once killed. For facility of observation I placed each nest in a closed box. On the 31st I carefully examined the nests and also the

boxes in which I had placed them. I could only distinguish one of the marked ants, but there were no dead ants either in the nests or boxes, except the two strangers.

I carefully examined the box in the same way for several successive mornings, but there was no dead ant. If there had been I must have found the body, and I am sure therefore that these ants were not attacked.

Again, on the 31st Aug. I put two more of the ants which had emerged from the pupæ taken out of nest B, and nursed by ants from that nest, into nest A at 10 A.M. At 10.30 they were quite comfortable amongst the others. At 11 I looked again and they seemed quite at home, as also at 11.30, after which I looked every hour. The next morning I found them evidently quite at home in the nest.

On the 15th September I put three of the ants which had emerged from the pupæ taken out of nest A, and nursed by ants from that nest, and put them into nest B at 1.30. They seemed to make themselves quite at home. I looked again at 2.30, with the same result. At 3.30 I could only find two, the third having no doubt been cleaned, but no ant was being attacked. At 5.30 they were no longer distinguishable, but if any one was being attacked we must have seen it. The next morning they all seemed quite peaceful, and there was no dead ant in the box. I looked again on the 17th and 19th, but could not distinguish them. As, however, there was no dead ant, they certainly had not been killed. I then put in a stranger; she was soon attacked and killed—showing that they would not tolerate an ant whom they did not recognize as in some way belonging to the community.

These observations seem to me conclusive as far as they go, and they are very surprising. In my experiments of last year, though the results were similar, still the ants experimented with had been brought up in the nest, and were only removed after they had become pupæ. It might therefore be argued that the ants having nursed them as larvæ, recognized them when they came to maturity; and though this would certainly be in the highest degree improbable, it could not be said to be impossible. In the present case, however, the old ants had absolutely never seen the young ones until the moment when, some days after arriving at maturity, they were introduced into the nest; and yet in all ten cases they were undoubtedly recognized as belonging to the community.

It seems to me therefore to be established by these experiments that the recognition of ants is not personal and individual; that their harmony is not due to the fact that each ant is individually acquainted with every other member of the community.

At the same time, the fact that they recognize their friends even when intoxicated, and that they know the young born in their own nest even when they have been brought out of the chrysalis by strangers, seems to indicate that the recognition is not effected by means of any sign or password.

Mr. McCook states that ants more or less soaked in water are no longer recognized by their friends, but, on the contrary, are attacked. Describing the following observation, he says*:—"I was accidentally set upon the track of an interesting discovery. An ant fell into a box containing water placed at the foot of a tree. She remained in the liquid several moments and crept out. Immediately she was seized in a hostile manner, first by one, then another, then by a third: the two antennæ and one leg were thus held. A fourth ant assaulted the middle thorax and petiole. The poor little bather was thus dragged helplessly to and fro for a long time, and was evidently ordained to death. Presently I took up the struggling heap. Two of the assailants kept their hold; one finally dropped, the other I could not tear loose, and so put the pair back upon the tree, leaving the doomed immersionist to her hard fate."

After repeating one or two other similar observations, he adds†:—"The conclusion, therefore, seems warranted that the peculiar odour or condition by which the ants recognize each other was temporarily destroyed by the bath, and the individuals thus 'tainted' were held to be intruders, alien and enemy. This conclusion is certainly unfavourable to the theory that any thing like an intelligent social sentiment exists among the ants. The recognition of their fellows is reduced to a mere matter of physical sensation or 'smell.'"

This conclusion does not, I confess, seem to me to be conclusively established.

Workers breeding.

In my last paper I brought forward some strong evidence tending to show that when workers laid eggs they always produced males. This is, however, a physiological fact of so much

* 'Mound-making Ants of the Alleghanies,' p. 280.

† Ibid. p. 281.

interest that I have carefully watched my nests this year also, to see what further light they would throw on the subject.

In six of those which contained no queen, eggs were produced, which of course must necessarily have been laid by workers.

The first of these, a nest of *Lasius niger*, which I have watched since July 1875, and which, therefore, is interesting from the great age of the workers, about ten larvæ were hatched, but only four reached the pupa state. Of these one disappeared; the other three I secured, and on examination they all proved to be males.

A second nest of *Lasius niger*, which has been under observation since November 1875, produced about ten pupæ. Of these I examined seven, all of which I found to be males. The others escaped me. I believe that, having died, they were brought out and thrown away.

A nest of *Formica cinerea*, captured at the same time, produced four larvæ, all of which perished before arriving at the pupa stage. They were certainly not workers.

In a nest of *Formica fusca* which I have had under observation since Aug. 1876, three pupæ were produced. They were all males.

Another nest of *Formica fusca* produced a single young one, which also was a male.

Lastly, my nest of *Polyergus rufescens*, which M. Forel was so good as to send me in the spring of 1876, and to which I have already frequently referred in these papers, produced twelve pupæ. Eleven of these turned out to be males. The other one I lost; but I have little doubt it was brought out and thrown away. At any rate it was not a worker. As regards the first three of these pupæ, I omitted to record whether they belonged to the *Polyergus* or to the slaves. The last eight were males of *Polyergus*.

Thus, then, this year again, in five of my queenless nests, males have been produced; and in not a single case has a worker laid eggs which have produced a female, either a queen or a worker. Perhaps I ought to add that workers are abundantly produced in those of my nests which possess a queen.

Again, as in previous years, so this season again, while great numbers of workers and males have come to maturity in my nests, not a single queen has been produced. We have, I think, therefore, strong reason for concluding that, as in the case of bees, so also in ants, some special food is required to develop the female embryo into a queen.

Longevity of Ants.

In my previous paper I have called attention to the considerable age attained by my ants, and I may perhaps be permitted to repeat here, *mutatis mutandis*, a paragraph from my last communication with reference to my most aged specimens, most of those mentioned last year being still alive. One of my nests of *Formica fusca* was brought from the woods in December 1874. It then contained two queens, both of which are now still alive*. I have little doubt that some of the workers now in the nest were among those originally captured, the mortality after the first few weeks having been but small. This, however, I cannot prove. The queens, however, are certainly six, and probably seven years old.

In the following nests—viz. another nest of *F. fusca*, which I brought in on the 6th June, 1875, one of *Lasius niger* on the 25th July, 1875, and of *Formica cinerea* on the 29th November, 1875—there were no queens; and, as already mentioned, no workers have been produced. Those now living are therefore the original ones, and they must be between five and six years old.

Though I lose many ants from accidents, especially in summer, in winter there are very few deaths.

The nest of *F. sanguinea*, which M. Forel kindly forwarded to me on the 12th Sept., 1875 (but which contained no queen), gradually diminished in numbers, until in Feb. 1879 it was reduced to two *F. sanguinea* and one slave. The latter died in Feb. 1880. One of the two mistresses died between the 10th and 16th May, 1880, and the other only survived her a few days, dying between the 16th and 20th. These two ants, therefore, must have been five years old at least. It is certainly curious that they should, after living so long, have died within ten days of one another. There was nothing, as far as I could see, in the state of the nest or the weather to account for this, and they were well supplied with food, yet I hardly venture to suggest that the survivor pined away for the loss of her companion.

Behaviour to strange Queens.

In a previous paper I have shown that, at least in the case of *Myrmica ruginodis*, the queen is capable of bringing larvæ to maturity, and consequently of founding a new nest by herself. Since, however, cases are on record in which communities are

* Aug. 3rd, 1880. They are still alive.

known to have existed for many years, it seems clear that fresh queens must be sometimes adopted. I have indeed recorded several experiments in which fertile queens introduced into queenless nests were ruthlessly killed, and subsequent experiments have always had the same result. Mr. Jenner Fust, however, suggested to me to introduce the queen into the nest, as is done with bees, in a wire cage, and leave her there for two or three days, so that the workers might, as it were, get accustomed to her. Accordingly I procured a queen of *F. fusca* and put her with some honey in a queenless nest, enclosed in a wire cage so that the ants could not get at her. After three days I let her out, but she was at once attacked. On the contrary, Mr. McCook reports the following case of the adoption of a fertile queen of *Cremastogaster lineolata* by a colony of the same species *:—"The queen," he says, "was taken in Fairmount Park, April 16th, and on May 14th following was introduced to workers of a nest taken the same day. The queen was alone within an artificial glass formicary, and several workers were introduced. One of these soon found the queen, exhibited much excitement but no hostility, and immediately ran to her sister workers, all of whom were presently clustered upon the queen. As other workers were gradually introduced they joined their comrades, until the body of the queen (who is much larger than the workers) was nearly covered with them. They appeared to be holding on by their mandibles to the delicate hairs upon the female's body, and continually moved their antennæ caressingly. This sort of attention continued until the queen, escorted by workers, disappeared in one of the galleries. She was entirely adopted, and thereafter was often seen moving freely, or attended by guards, about the nest, at times engaged in attending the larvæ and nymphs which had been introduced with the workers of the strange colony. The workers were fresh from their own natural home, and the queen had been in an artificial home for a month."

Possibly the reason for the difference may be that my ants had been long living in a republic, for, I am informed, that if bees have been long without a queen it is impossible to induce them to accept another.

Moreover, I have found that when I put a queen with a few

* Proc. Acad. Natural Sciences of Philadelphia, 1879. "Note on the Adoption of an Ant-Queen," by Mr. McCook, p. 139.

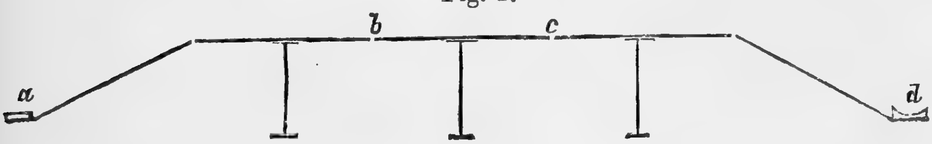
ants from a strange nest they did not attack her, and by adding others gradually, I succeeded in securing the throne for her.

Sense of Direction.

Having been much struck by the difficulty which ants appear under certain circumstances to experience in finding their way, as indicated, for instance, by some experiments which the Society has done me the honour to publish (Journ. Linn. Soc. vol. xiii. pp. 239–245), I have during the past year made some more experiments on this part of the subject.

I accustomed some ants (*Lasius niger*) to go to and fro to food over a wooden bridge (fig. 1).

Fig. 1.

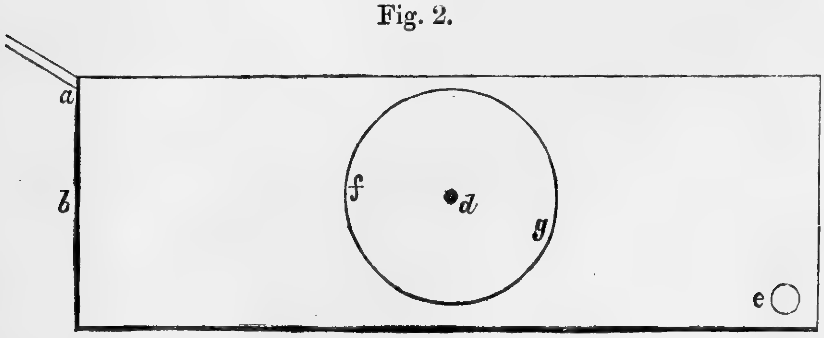


When they had got quite accustomed to the way, I watched when an ant was on the bridge and then turned it round, so that the end *b* was at *c*, and *c* at *b*. In most cases the ant immediately turned round also; but even, if she went on to *b* or *c*, as the case may be, as soon as she came to the end of the bridge she turned round.

I then modified the arrangement, placing between the nest and the food three similar pieces of wood. Then when the ant was on the middle piece, I transposed the other two. To my surprise this did not at all disconcert them.

I then tried the arrangement shown in fig. 2.

Fig. 2.



a is a paper bridge leading to the nest; *b* is a board about 22 inches long by 13 broad, on which is a disk of white paper fas-

tened at the centre by a pin *d*; *e* is some food. When the ants had come to know their way so that they passed straight over the paper disk on their way from *a* to *e*, I moved the disk round with an ant on it, so that *f* came to *g* and *g* to *f*. As before, the ants turned round with the paper.

As it might be possible that the ants turned round on account of the changed relative position of external objects, I next substituted a box 12 inches in diameter and 7 inches high (in fact a hat-box) for the flat paper, cutting two small holes at *f* and *g*, so that the ants passing from the nest to the food went through the box entering at *f* and coming out at *g*. The box was fixed at *d*, so that it might turn easily. I then, when they had got to know their way, turned the box round as soon as an ant had entered it, but in every case the ant turned round too, thus retaining her direction. I then varied the experiment as shown in figs. 3 and 4.

Fig. 3.

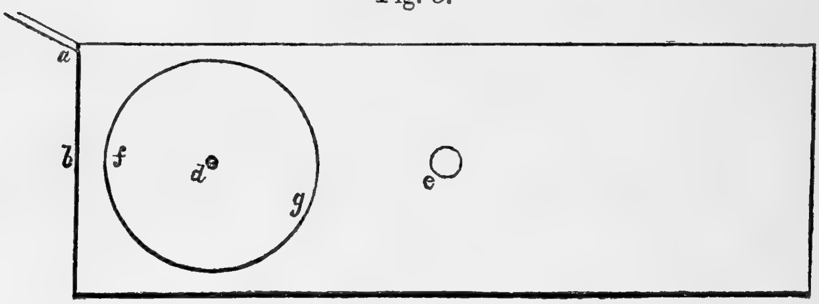
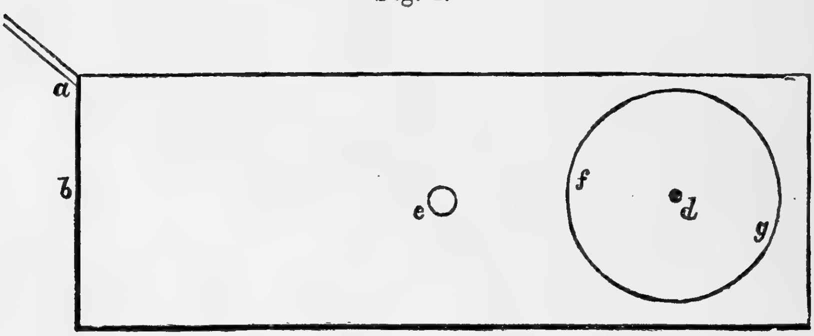


Fig. 4.



I replaced the white disk of paper, but put the food *e* at the middle of the board. When the ant had got used to this arrangement I waited till one was on the disk (fig. 3) and then gently drew it to the other side of *e*, as shown in fig. 4. In this case, however, the ant did not turn round, but went on to *g*, when she seemed a good deal surprised at finding where she was.

As to Hearing and Experiments with Telephone.

In order to ascertain if possible whether ants made any sounds which were audible to one another, I thought I would try the telephone. Accordingly I looked for two ants' nests (*Lasius niger*) not far from one another, and then, after disturbing one of them, had a telephone held just over it. I then held the second telephone close over the other nest, each telephone being perhaps one to two inches above the ground. If the disturbed ants made any sound which was transmitted by the telephone, the ants in the other nest ought have been thrown into confusion. I could not, however, perceive that it made the slightest difference to them. I tried the experiment three or four times, always with the same result.

I then put some syrup near a nest of *L. niger*, and when several hundred ants were feeding on the syrup, I blew on the nest, which always disturbs them very much. They came out in large numbers and ran about in great excitement. I then held one end of the telephone over the nest, the other over the feeding ants, who, however, took not the slightest notice.

I cannot, however, look on these experiments as at all conclusive, because it may well be that the plate of the telephone is too stiff to be set in vibration by any sounds which ants could produce.

On the Sting of Formica.

M. Dewitz, in an interesting paper published in the Zeitschr. für wiss. Zool. vol. xxviii., has given an account of the structure and development of the sting in ants*. *Formica rufa*, and other so-called "stingless" ants, do really possess a sting, although it is but rudimentary, and, indeed, serves only as a support for the duct of the poison-gland. Now under these circumstances a sting might either be rudimentary in the sense of undeveloped, and the sting might represent a rudimentary and archaic structure from which the more perfect organ of the other ants, as, for instance, of the Myrmicidæ, had developed itself; or, secondly, it

* "Das der Formicidenstachel kein verkümmertes Organ ist, sondern ein auf der niedrigsten Stufe der Entwickelung stehen gebliebenes, aus dem der ausgebildete Stachel hervorging, wir es also nicht mit einem *Rückschritt* sondern mit einem primitivem Organe zu thun haben" (Zeitschrift für wissenschaftliche Zoologie, vol. xxviii. p. 551).

might be an organ which, having fallen out of use, had become atrophied. M. Dewitz adopts the former view. He concludes that the rudimentary sting of the Formicidæ is not a stunted and evanescent organ, but one which has remained in the lowest stage of development, from which the more perfect sting has originated—that we have to do not with a reduced, but with a primitive organ.

Any opinion expressed by M. Dewitz on such a subject is, of course, entitled to much weight; nevertheless there are some general considerations which seem to me conclusive against his view. If the sting of *Formica* represents a hitherto undeveloped organ, then the original ant was stingless, and the present stings of the aculeate ants have an origin independent of that belonging to the other aculeate Hymenoptera, such as bees and wasps. These organs, however, are so complex, and at the same time so similarly constituted, that they must surely have a common origin. Whether the present sting is derived from a leaf-cutting instrument, such as that from which the sawfly takes its name, I will at present express no opinion. M. Dewitz would surely not regard the rudimentary traces of wings in the larvæ of ants as undeveloped organs; why, then, should he adopt this view with reference to the rudimentary sting? On the whole I must regard the ancestral ant as having been aculeate, and consider that the rudimentary condition of the sting of *Formica* is due to atrophy, perhaps through disuse.

On the Arrangement of their Nests.

I have given the following figure (fig. 5), which represents a typical nest belonging to *Lasius niger*, because it seems to show some ideas of strategy. The nest is between two plates of glass, the outer border is a framework of wood, and the darker colour represents garden mould, which the ants have themselves excavated, as shown in the figure. For the narrow doorway (*a*), indeed, I am myself responsible. I generally made the doorways of my nests narrow, so as to check evaporation and keep the nests from becoming too dry. It will be observed, however, that behind the vestibule (*b*) the entrance contracts, still further protected by a pillar of earth, which leaves on either side a narrow passage which a single ant could easily guard, or which might be quickly blocked up. Behind this is an irregular vestibule (*c*), contracted again behind into a narrow passage, which is followed by another, this latter opening into the main chamber *d*. In this chamber

several pillars of earth are left, almost as if to support the roof. Behind the main chamber is an inner sanctum divided into three chambers, and to which access is obtained through narrow entrances (*f*, *f*, *f*, *f*). Most of the pillars in the main chamber are irregular in outline, but two of them (*g*, *g*) were regular ovals,

Fig. 5.

Ground-plan of a typical nest of *Lasius niger*, reduced. *a*, narrow doorway; *b*, widening beyond entrance; *c*, vestibule; *d*, main chamber; *e*, inner sanctum; *f*, *f*, *f*, *f*, narrow entrance passages to sanctum; *g*, *g*, special pillars.

and round each, for a distance about as long as the body of an ant, the glass had been most carefully cleaned. This was so marked, and the edge of the cleaned portion was so distinct that it is im-

possible not to suppose that the ants must have had some object in this proceeding, though I am unable to suggest any explanation of it.

On the treatment of Aphides.

Our countryman Gould, whose excellent little work on ants* has hardly received the attention it deserves, observes that "the queen ant [he is speaking of *Lasius flavus*] lays three different sorts of eggs, the slave, female, and neutral. The two first are deposited in the spring, the last in July and part of August; or, if the summer be extremely favourable, perhaps a little sooner. The female eggs are covered with a thin black membrane, are oblong, and about the sixteenth or seventeenth part of an inch in length. The male eggs are of a more brown complexion, and usually laid in March."

Here, however, our worthy countryman fell into an error, the eggs which he thus describes not being those of ants, but, as Huber correctly observed, of Aphides †. The error is the more pardonable, because the ants treat these eggs exactly as if they were their own, guarding and tending them with the utmost care. I first met with them in February 1876, and was much astonished, not being at that time aware of Huber's observations. I found, as Huber had done before me, that the ants took the greatest care of these eggs, carrying them off to the lower chambers with the utmost haste when the nest was disturbed. I brought some home with me and put them near one of my own nests, when the ants carried them inside. That year I was unable to carry my observations further. In 1877 I again procured some of the same eggs, and offered them to my ants, who carried them into the nest, and in the course of March I had the satisfaction of seeing them hatch into young Aphides. M. Huber, however, does not think these are mere ordinary eggs. On the contrary, he agrees with Bonnet, "that the insect, in a state nearly perfect, quits the body of its mother in that covering which shelters it from the cold in winter, and that it is not, as other germs are, in the egg surrounded by food by means of which it is developed and supported. It is nothing more than an asylum of which the Aphides born at another season have no need; it is on this account some are produced naked, others enveloped in a covering. The mothers

* An Account of English Ants. By the Rev. W. Gould, 1747, p. 36.

† My lamented friend Mr. Smith also observed these eggs (Entom. Annual, 1871). He did not, however identify the species to which they belonged.

are not, then, truly oviparous, since their young are almost as perfect as they ever will be, in the asylum in which Nature has placed them at their birth" *.

This is, I think, a mistake. This is not the opportunity to describe the anatomy of the Aphis; but I may observe that I have examined the female, and find these eggs to arise in the manner so well described by Huxley in our 'Transactions'†, and which I have also myself observed in other Aphides and in allied genera‡. Moreover, I have opened the eggs themselves, and have also examined sections, and have satisfied myself that they are true eggs containing ordinary yelk. If examined while still in the ovary the germ-vesicle presents the usual appearance, but in laid eggs I was unable to detect it. So far from the young insect being "nearly perfect," and merely enveloped in a protective membrane, no limbs or internal organs are present. These bodies are indeed real ova, or pseudova; and the young Aphis does not develop in them until shortly before they are hatched.

When my eggs hatched I naturally thought that the Aphides belonged to one of the species usually found on the roots of plants in the nests of *Lasius flavus*. To my surprise, however, the young creatures made the best of their way out of the nest, and, indeed, were sometimes brought out by the ants themselves. In vain I tried them with roots of grass &c.; they wandered uneasily about, and eventually died. Moreover, they did not in any way resemble the subterranean species. In 1878 I again attempted to rear these young Aphides; but though I hatched a great many eggs, I did not succeed. This year, however, I have been more fortunate. The eggs commenced to hatch the first week in March. Near one of my nests of *Lasius flavus*, in which I had placed some of the eggs in question, was a glass containing living specimens of several species of plant commonly found on or around ants' nests. To this some of the young Aphides were brought by the ants. Shortly afterwards I observed on a plant of daisy, in the axils of the leaves, some small Aphides, very much resembling those from my nest, though we had not actually traced them continuously. They seemed thriving, and remained stationary on the daisy. Moreover, whether they had sprung from the black eggs or not, the ants evidently valued them, for they built up a wall of earth round and over them. So things remained throughout the summer; but on the 9th Oct. I found that

* The Natural History of Ants. By M. P. Huber, 1820, p. 246.

† Trans. Linn. Soc. vol. xxii. (1859). ‡ Philosophical Transactions, 1859.

the Aphides had laid some eggs exactly resembling those found in the ants' nests; and on examining daisy-plants from outside, I found on many of them similar Aphides, and more or less of the same eggs.

I confess these observations surprised me very much. The statements of Huber have not, indeed, attracted so much notice as many of the other interesting facts which he has recorded; because if Aphides are kept by ants in their nests, it seems only natural that their eggs should also occur. The above case, however, is much more remarkable. Here are Aphides, not living in the ants' nests, but outside, on the leaf-stalks of plants. The eggs are laid early in October on the food-plant of the insect. They are of no direct use to the ants, yet they are not left where they are laid, where they would be exposed to the severity of the weather and to innumerable dangers, but brought into their nests by the ants, and tended by them with the utmost care through the long winter months until the following March, when the young ones are brought out and again placed on the young shoots of the daisy. This seems to me a most remarkable case of prudence. Our ants may not perhaps lay up food for the winter, but they do more, for they keep during six months the eggs which will enable them to procure food during the following summer.

No doubt the fact that our European ants do not generally store up food in the usual way is greatly due to the nature of their food. They live, as we know, partly on insects and other small animals which cannot be kept fresh; and they have not learnt the art of building vessels for their honey, probably because their young are not kept in cells like those of the honey-bee, and their pupæ do not construct firm cocoons like those of the humble-bee.

Moreover, it is the less necessary for them to do so, because if they obtain access to any unusual store of honey, that which they swallow is only digested by degrees and as it is required; so that, as the camel does with water, they carry about with them in such cases a supply of food which may last them a considerable time. They have, moreover, as we know, the power of regurgitating this food at any time, and so supplying the larvæ or less fortunate friends. Even in our English ants the quantity of food which can be thus stored up is considerable in proportion to the size of the insect; and if we watch, for instance, the little brown garden-ant (*Lasius niger*) ascending a tree to milk their

Aphides, and compare them with those returning full of honey, we shall see a marked difference in size.

On a new Species of Honey-Ant, Camponotus inflatus.

I have, indeed, no reason to suppose that in our English ants any particular individuals are specially told off to serve as receptacles of food. M. Wesmael, however, has described* a remarkable genus (*Myrmecocystus mexicanus*), brought by M. de Normann from Mexico, in which certain individuals in each nest serve as animated honey-pots. To them the foragers bring their supplies, and their whole duty seems to be to receive the honey, retain it, and redistribute it when required. Their abdomen becomes enormously distended, the intersegmental membranes being so much extended that the chitinous segments which alone are visible externally in ordinary ants seem like small brown transverse bars. The account of these most curious insects given by MM. de Normann and Wesmael has been fully confirmed by subsequent observers; as, for instance, by Lucas†, Saunders‡, Edwards§, Blake‖, Loew¶, and McCook.

On one very important point, however, M. Wesmael was in error; he states that the abdomen of these abnormal individuals "ne contient aucun organe; ou plutôt, il n'est lui-même qu'un vaste sac stomacal." Blake even asserts that "the intestine of the insect is not continued beyond the thorax," which must surely be a misprint; and also that there is no connexion "between the intestine and the cloaca"! These statements, however, are entirely erroneous; and, as M. Forel has shown, the abdomen does really contain the usual organs, which, however, are very easily overlooked by the side of the gigantic stomach.

I have now the honour of exhibiting to the Society a second species of ant, which has been sent me by Mr. Waller, in which a similar habit has been evolved and a similar modification has been produced. The two species, however, are very distinct, and the former is a native of Mexico, while the present comes from Adelaide in Australia. The two species, therefore, cannot be

* Bull. de l'Acad. des Sci. de Bruxelles.
† Ann. Soc. Ent. de France, v. p. 111.
‡ 'Canadian Entomologist,' vol. vii. p. 12.
§ Proc. California Academy, 1873. ‖ Ibid. 1874.
¶ American Nat. viii. 1874.

descended one from the other; and it seems incredible that the modification has originated independently in the two species.

It is interesting that, although these specimens apparently never leave the nest, and have little use therefore for legs, mandibles, &c., the modifications which they have undergone seem almost confined to the abdominal portion of the digestive organs. The head and thorax, antennæ, jaws, legs, &c. differ but little from those of ordinary ants.

CAMPONOTUS INFLATUS, n. sp. (Plate VIII.)

Operaria. Long. 15 mill. Nigra, tarsis pallidioribus; subtiliter coriacea, setis cinereo-testaceis sparsis; antennis tibiisque haud pilosis; tarsis infra hirsutis; mandibulis punctatis, hirsutis, sexdentatis; clypeo non carinato, antice integro; petioli squama modice incrassata, antice convexa, postice plana emarginata.

Hab. Australiam?

The colour is black, the feet being somewhat paler. The body is sparsely covered with stiff cinereo-testaceous hairs, especially on the lower and anterior part of the head, the mandibles, and the posterior edge of the thorax. The head and thorax are finely coriaceous.

The antennæ are of moderate length, twelve-jointed; the scape about one third as long as the terminal portion and somewhat bent. At the apex of the scape are a few short spines, bifurcated at the point. At the apex of each of the succeeding segments are a few much less conspicuous spines, which decrease in size from the basal segments outwards. The antenna is also thickly clothed with short hairs, and especially towards the apex with leaf-shaped sense-hairs. The clypeus is rounded, with a slightly developed median lobe and a row of stiff hairs round the anterior border; it is not carinated.

The mandibles have six teeth, those on one side (fig. 3) being rather more developed and more pointed than those on the other. They decrease pretty regularly from the outside inwards.

The maxillæ (fig. 5) are formed on the usual type. The maxillary palpi are six-jointed, the third segment being but slightly longer than the second, fourth, or fifth; while in *Myrmecocystus* the third and fourth are greatly elongated. The segments of the palpi have on the inner side a number of curious curved blunt hairs besides the usual shorter ones.

The labial palpi are four-jointed (fig. 4). The eyes are elliptical and of moderate size. The ocelli are not developed.

The thorax (figs. 7 and 8) is arched, broadest in front, without any marked incision between the meso- and metanotum ; the mesonotum itself is, when seen from above, very broadly oval, almost circular, rather broader in front and somewhat flattened behind. Figs. 7 & 8 give outlines of the thorax, seen laterally and from above. The legs are of moderate length, the hinder ones somewhat the longest. The scale or knot (fig. 6) is heart-shaped, flat behind, slightly arched in front, and with a few stiff, slightly diverging hairs at the upper angles. The length is about two thirds of an inch.

DESCRIPTION OF PLATE VIII.

Fig. 1.	*Camponotus inflatus.*	Head, seen from above,	×20.
2.	„ „	Antenna, „	×25.
3.	„ „	Mandible, „	„
4.	„ „	Labium, „	„
5.	„ „	Maxilla, „	„
6.	„ „	Knot, seen from behind	„
7.	„ „	Outline of thorax, seen from the side,	×9.
8.	„ „	Outline of thorax, seen from above,	×9.

Pro. Pronotum ; *Mes.* Mesonotum ; *Met.* Metanotum.

On the Genus *Solanocrinus*, Goldfuss, and its Relations to recent *Comatulæ*. By P. Herbert Carpenter, M.A., Assistant Master at Eton College.

[Read June 3, 1880.]

(Plates IX -XII.)

The genus *Solanocrinus* was established by Goldfuss* to include certain fossil Crinoids which he regarded as intermediate between the stalked *Pentacrini* and the free *Comatulæ*. He placed them among the stalked Crinoids, however, on account of their usually having a centrodorsal piece somewhat deeper than that of the few recent *Comatulæ* known to him ; so that he was led to regard it as a short stem composed of but few joints. Between this so-called

* 'Petrefacta Germaniæ,' i. p. 162.

stem and the united radials he found (in most of his specimens) five basal pieces of variable size (Pl. IX. figs. 1, 2, Pl. X. figs. 14, 15). These are not visible in most recent *Comatulæ*, but were apparently represented in an exceptional species from the Indian Ocean, which Goldfuss referred to *C. multiradiata*, Lam.* The specimen was dissected and described by him; but no similar one has since been found. It seems to have had basals analogous to those of *Solanocrinus*; but Goldfuss described its centrodorsal as consisting of one piece only, while he believed that of *Solanocrinus* to be made up of three or more anchylosed rings.

Although he recognized the great resemblance between this *Comatula* (which he supposed to be the type of many others) and the forms described by himself as *Solanocrinus*, yet he placed the latter among the stalked Crinoids for the reasons already given; though he mentioned at the same time that they were probably not "festgewürzelt" any more than the *Comatulæ* are.

Agassiz† erected the *Comatula multiradiata* of Lamarck into a new genus, *Comaster*, distinguished by its having the arms ramified instead of simply forked. He naturally included in this genus the many-armed specimen dissected by Goldfuss, who adopted this name for it‡, apparently under the impression that all the multiradiate *Comatulæ* possessed external basals. It was this character, however, and not the ramification of the arms, that he regarded as distinctive of the genus *Comaster*. This definition of *Comaster* was employed by Müller§, though, oddly enough, he ascribed it to Agassiz; and in this mistake he has been followed by most later naturalists. It must be remembered, therefore, that *Comaster*, Ag., is by no means the same as *Comaster*, Goldf. The latter type is the one with which we are especially concerned; and although Müller united it with *Solanocrinus*, Goldfuss continued to regard it as distinct on account of the supposed differences between their respective centrodorsal pieces; and expressly stated that it had no fossil representatives. Both were distinguished from the ordinary *Comatulæ* by the presence

* *Tom. cit.* p. 202.

† "Prodrome d'une Monographie des Radiaires ou Échinodermes," Ann. des Scien. Nat. 2e série, Zool. vii. p. 257.

‡ "Beiträge zur Petrefactenkunde," Nov. Acta Acad. Leop.-Carol. Nat.-Cur. xix. A. p. 348.

§ "Ueber den Bau des *Pentacrinus caput medusæ*," Separat-Abdruck aus den Abhandl. d. Berlin. Akad. 1843, p. 27.

of external basals. Subsequently, however, Müller gave up the genus *Comaster* (and *Solanocrinus* with it), chiefly because he had examined several species of free Crinoids without ever finding one with external basals*. But Roemer†, a few years later, while uniting *Solanocrinus* and *Comaster*, retained the latter name as designating a type, distinct from *Comatula* with no external basals. About the same time d'Orbigny‡ threw all these three, together with "*Glenocrinus*, Goldf." (i. e. *Glenotremites*), into one genus, to which he assigned Lamarck's name *Comatula*:—"Nous y conservons les espèces pourvues de cinq petites pièces basales, entre les cinq pièces brachiales et la pièce centrale épaisse, portant dix séries de ramules égales. Cinq bras bifurqués une ou plusieurs fois. Le calice mal observé par M. Goldfuss a servi à l'établissement de ses genres *Glenocrinus* (*sic*) et *Solanocrinus*."

D'Orbigny was rather hard on Goldfuss in accusing him of incorrect observation. As both of his specimens of *Glenotremites* consisted of the centrodorsal piece only (neither with ten rows of cirrhus-sockets), he could hardly have been expected to describe basals which he did not see. Lundgren § has already pointed out that their presence was assumed by d'Orbigny, who, on the evidence before him, might, with equal justice, have referred *Glenotremites* to his next genus *Decameros*, by which he meant *Decacnemus*, Linck. He characterized this type by the absence of external basals; and to it he should have referred Lamarck's genus *Comatula*, as he did the *Antedon* of de Freminville and the *Alecto* of Leach. All the species of *Comatula* described by Lamarck are devoid of external basals, as d'Orbigny could have determined by a personal examination of them. For some unexplained reason, however, he referred them to *Comatula as he defined it*, namely *with* external basals.

D'Orbigny's peculiar redistribution of generic names was partly followed by Pictet ||, who regarded *Glenotremites* as distinct and as presenting "special characters." He proposed a modification of d'Orbigny's nomenclature, in that he would retain

* "Ueber die Gattung *Comatula*, Lam., und ihre Arten," Separat-Abdruck aus den Abhandl. d. Berlin. Akad. 1849, p. 8 (244).

† Lethæa Geognostica, iii[te] Auflage, 1851, Theil iv. p. 133, & Theil v. p. 177.

‡ 'Cours élément. de Paléontol. et de Géol. stratigraph.' 1850–52, vol. ii. (i.) p. 138.

§ "Om en *Comaster* och en *Aptychus* från Kopinge," Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar, 1874, No. 3, p. 64, note.

|| 'Traité de Paléontologie,' vol. iv. p. 288.

the name *Comatula* only for the peculiar form described by Goldfuss as *Solanocrinus Jaegeri* (Pl. XI. fig. 24), in which there is a closed circlet of basals, all species with an incomplete basal ring being then referred to *Solanocrinus*. As I hope to show later on that *S. Jaegeri* is the stemless head of a *Pentacrinus*, and not a *Comatula* at all, I cannot accept Pictet's classification, which has not found favour with any of my predecessors.

Müller's views reappeared in 1860 in Bronn's 'Thierreich'*, in which *Solanocrinus*, *Comaster*, and *Comatula* were united under one name, *Comatula*. Two years later Dujardin and Hupé† removed the first two types again under the single name *Comaster*; while in 1866 Lovén‡ reunited *Comaster* and *Comatula* on the ground that Goldfuss's analysis of the calyx of the former could not be correct. He suggested that the so-called "basals" of Goldfuss were merely the angles of the first radials; but this cannot have been the case, if any reliance is to be placed on Goldfuss's figure of the dissected calyx. Lundgren§ identifies *Comaster* with *Solanocrinus*, but prefers the former name, which he has given to a Cretaceous type presenting a considerable resemblance to the Jurassic forms described by Goldfuss as *Solanocrinus*. De Loriol‖ thought (in 1868) that the presence of external basals might be sufficient to separate *Solanocrinus* from *Comatula*; but he has since united them under the pre-Lamarckian name *Antedon*¶. Quenstedt** does not seem to consider *Comaster* as generically different from the other recent *Comatulæ*; and although he retains *Solanocrinus* as distinct from the latter, he remarks that there seems to be no essential difference between them.

Schlüter††, believing that the reasons which led Goldfuss to separate *Comaster* and *Solanocrinus* are no longer tenable, places them,

* Band ii. Aktinozoen (1860), p. 233.

† 'Hist. Nat. des Zoophytes, Échinodermes' (Paris, 1862), p. 186.

‡ "Phanogenia, ett hittills okändt slägte af fria Crinoideer," Öfvers. af Kongl. Vetensk.-Akad. Förhandl. 1866, No. 9, p. 226.

§ *Loc. cit.* pp. 63, 69.

‖ "Monographie des Couches de l'étage Valangien d'Arzier." Pictet, Matériaux pour la Paléontologie Suisse, 4e série, p. 84.

¶ "Monographie des Crinoides fossiles de la Suisse," Mém. Soc. Paléontol. Suisse, 1879, p. 254.

** 'Petrefactenkunde Deutschlands,' Bd. iv. Asteriden und Encriniden, pp. 165, 171.

†† "Ueber einige astylide Crinoiden," Zeitschr. d. deutsch. geol. Gesellsch., Jahrg. 1878, p. 36.

together with *Glenotremites* and the typical *Comatulæ*, in the single genus *Antedon*; while Zittel*, using *Antedon* as equivalent to *Comatula* in its older meaning, separates off certain well-marked recent types as subgenera, and assigns the same position to *Solanocrinus*, with which he groups *Comaster* and *Glenotremites*. I have shown elsewhere†, however, that our scanty knowledge of the organization of *Comaster* (supposing Goldfuss to have been accurate) is sufficient to show us that it is a very peculiar form. There are many and striking differences between it and other recent Crinoids, to which *Solanocrinus* is much more closely allied than to *Comaster*. Schlüter‡ doubts whether the mere fact that the embryonic basals of recent *Comatulæ* undergo a partial resorption and transformation into the rosette is a sufficient reason for regarding them as generically distinct from *Solanocrinus*, in which they are more or less distinctly developed on the exterior of the calyx. The difference is an important one, however, from a morphological point of view; but I do not think that it is one of any practical value, on account of the difficulty of determining the presence of a rosette in fossil *Comatulæ*. So far as I know, all recent *Comatulæ* (excluding *Comaster*) have a rosette; but this is absent in all the fossil forms in which we are able to see the base of the calyx. But even in these the primitive unmetamorphosed basals do not always reach the exterior of the calyx, being sometimes invisible when the centrodorsal is *in situ*. Hence the absence of external basals in a fossil *Comatula* is not a sure sign of the presence of a rosette internally; so that I do not think it possible to make any generic distinction between the forms with external basals and those without them. I therefore follow Müller, Schlüter, and de Loriol in uniting *Solanocrinus* with *Comatula*, which is practically the same as with *Antedon*; for I cannot refer any of the known species of *Solanocrinus* to the type of *Actinometra*.

I.—The type of *S. costatus*, as represented by Goldfuss§, is a *Comatula* with a centrodorsal piece in the form of a short rounded pentagonal column on which there are ten vertical rows of cirrhus-sockets. These rows are separated by vertical ribs, of which

* Handbuch der Paläontologie, I. Band, p. 396.

† Journ. Linn. Soc. Zoology, vol. xiii. pp. 454–456.

‡ *Op. cit.* p. 36.

§ *Op. cit.* tab. l. fig. 7.

the five that are situated interradially are the strongest (Pl. IX. fig. 1). Resting on their summits there appear the rounded ends of the prismatic basals that intervene between the lower angles of the radials and the upper surface of the centrodorsal. The distal faces of the radials do not rise directly from the margin of the centrodorsal, as in most recent *Comatulæ*; but they are separated from it by a portion of their dorsal surface that appears externally, as in *Pentacrinus* (Pl. XI. figs. 21 *a*, 23 *a*). I have elsewhere* called this the "outer dorsal surface," in contradistinction to the "inner dorsal surface," that rests on the centrodorsal piece. The distal articular faces have a considerable slope inwards towards the vertical axis of the calyx, and have very distinct intermuscular notches in the middle of their upper borders that lead into the corresponding furrows of the ventral faces. There are also distinct interradial notches between the muscle-plates of every two adjacent radials, which are continuous with the ventral interradial furrows on the upper surface of the calyx.

A careful study of several specimens commonly referred to this type has shown me, not only that it exhibits a great amount of variation within what may fairly be regarded as specific limits, but also that many forms have been referred to it which differ from it in several points. Many of these differences are of the same nature as those which exist between the corresponding parts of various recent *Comatulæ*, and are always accompanied by variations in other characters that necessarily remain unknown for the fossil forms. The shape and relative proportions of the centrodorsal and radials vary considerably among the different species of recent *Comatulæ* (Pl. XII.); and one seems justified in concluding that variations of a similar character among the fossil forms may be taken as indicative of specific differences. In this way I hope to show that the *Comatula*-fauna of the White Jura of Wurtemburg was considerably more varied than has hitherto been supposed.

I have never seen any specimen of *Solanocrinus* precisely like the type of *S. costatus* (=*Antedon costata*, Pl. IX. fig. 1). There are, however, three specimens in the Woodwardian Museum and one in the British Museum, all from Nattheim, that resemble it very closely. Apart from irregularities in the development

* "Preliminary Report upon the *Comatulæ* of the 'Challenger' Expedition," Proc. Roy. Soc. No. 194, 1879, p. 392.

of the basals, these four all differ in the height of the outer surfaces of the radials. In none of them does it reach the same relative proportion that it does in Goldfuss's figure (Pl. IX. fig. 1 *a*). There is also a considerable amount of variation in the proportions between the height and width of the articular faces, in the shapes of their muscle-plates, and in the relations between the diameter of the central funnel and that of the entire calyx In Goldfuss's figure the upper ends of the muscle-plates are bluntly pointed, their superior margins sloping sharply downwards towards the intermuscular notch; but in three of the specimens before me they are more squared and nearly horizontal. Further, while the total diameter of my figure of the top of the calyx (Pl. IX. fig. 2 *b*) and the corresponding one of Goldfuss (Pl. IX. fig. 1 *b*) is the same, the diameters of the central funnel are very different in the two cases, being 16 millims. in fig. 2 *b*, but only 12 millims. in Goldfuss's figure (Pl. IX. fig. 1 *b*). This appears to be due to the distal faces of the radials of the Cambridge specimen having a rather less inward slope than those of Goldfuss's specimen.

There is yet another difference between the type and most of the specimens of *Antedon costata* which I have examined. In the former the cirrhus-sockets are regularly arranged in ten vertical rows. In the latter they are larger and much less regular, very much as in the specimen represented in Quenstedt's 'Encriniden' (pl. 96. fig. 32), which has squarish muscle-plates. On the other hand, his fig. 33 represents a specimen with a more regular centrodorsal and pointed muscle-plates; but it differs from the type in having no interradial notches between the muscle-plates of contiguous radials. The specimen figured by Quenstedt in 'Der Jura,' tab. 88. fig. 10 (reproduced here on Pl. IX. fig. 4) is also different from the type, as the outer dorsal surface of the radials is greatly reduced. In this respect it is just at the opposite extremity of the series to Goldfuss's specimen, in which the exterior of the radials is unusually large (Pl. IX. fig. 1 *a*).

These differences are slight exaggerations of the kind of variation that one finds in recent *Comatulæ*; but they are insufficient to form the basis of specific distinctions. Curiously enough, one of the Cambridge specimens shows how variation may occur even in individual cases. It is slightly smaller than the others, with a more regularly ribbed centrodorsal (as in Goldfuss's specimen), and a relative width of the central funnel which is intermediate

between the two measurements given above; while the shape of its muscle-plates is not constant, their upper ends being bluntly pointed in some cases (like Pl. IX. fig. 1 *a*), but more squared in others (like Pl. IX. fig. 2 *a*).

Diameter of the specimen figured (Pl. IX. fig. 2), $13\frac{1}{2}$ millims. Total height $10\frac{1}{2}$ millims.; of the radials alone $5\frac{1}{2}$ millims.

All the Cambridge specimens of *Antedon costata* agree with the type in the first radials having a considerable outer dorsal surface, so as to have been distinctly visible externally when the second radials were in position. The same is the case with all the adult specimens of *A. costata* figured by Quenstedt on pl. 96 of his 'Encriniden,' and also in nearly all the allied species figured by de Loriol in his 'Fossil Crinoids of Switzerland.' In his 'Jura,' however (pl. 88. fig. 10), Quenstedt gives a small figure, which I reproduce here (Pl. IX. fig. 4), of a form in which the first radials have an unusually small exterior. The centrodorsal and the other characters of the radials resemble those of the type so far as can be judged from the figure, which is too small to be quite satisfactory. The specimen is interesting from its being a transitional form towards the next type, which must, I think, be regarded as distinct from *A. costata.*

II.—On pl. 51. fig. 36 of his 'Petrefactenkunde,' Quenstedt gives a small and indistinct figure of a Nattheim specimen that differs from the type species in the relations of the external surface of the radials. It does not continue the upward slope of the centrodorsal as in the type, but is nearly at right angles to it, so as to look almost directly downwards over the edge of the centrodorsal beyond which it projects, and not downwards and outwards. There is a small specimen in the British Museum from the same locality that agrees with Quenstedt's figure in this and other features, but differs from it in points of detail. The articular faces are much wider relatively to their height, and have a groove along their dorsal edges just below the fossa for the elastic ligament (Pl. IX. fig. 3). There are large basals at the angles of the calyx, and the centrodorsal is in the form of a truncated cone bearing ten rows of cirrhus-sockets, but little traces of which are visible, as the specimen is somewhat worn. The division between the muscular and ligament fossæ has also become obliterated, as in most of the Nattheim specimens.

The specimen figured is 6 millims. high, with a diameter of 8 millims. I propose the name *Antedon truncata* for this type.

III.—This leads us on to another rather peculiar form, viz. that represented on pl. 88. fig. 9 of Quenstedt's 'Jura,' which I reproduce (Pl. IX. fig. 5). The centrodorsal is less ribbed than in the type of *A. costata*, and the cirrhus-sockets relatively larger but less numerous. The peculiarity of this form is that the radials have no external surface at all. Their articular faces rise directly from the upper surface of the centrodorsal, which bears the whole of their dorsal surfaces, no part of these appearing externally. They are more concealed than in any recent *Comatulæ*, in which their presence is usually just indicated by a line or a ridge between the articular surfaces and the centrodorsal. At the angles of the calyx are large basals partially separating the lower angles of the radials from the centrodorsal, but encroaching much more on the latter than on the former.

IV.—The next type to be considered is an imperfect specimen from Nattheim now in the British Museum (Pl. IX. fig. 6). The centrodorsal is essentially like that of *A. costata*, except that the cirrhus-sockets are not quite so regularly disposed in ten rows, and the ribs separating the rows are less prominent. The exterior of the radials is very low, and it is not convex, as is usually the case, but has an irregular groove running along it. Only three of the five radials remain; but only two basals are visible at the four angles corresponding to them (Pl. IX. figs. 6 *a*, 6 *b*), and they do not project outwards at all. They are the smaller ends of tapering rods which are seen sideways in fig. 6 *c*. Their larger central ends are partially concealed by matrix, but seem to have been in contact laterally, and to have received the lower ends of the ventral interradial furrows which are seen descending towards them in fig. 6 *c*. The upper angles of the calyx are but slightly notched in correspondence with these furrows, and the intermuscular notches of the articular faces are also very slightly marked.

The diameter of this specimen is 14 millims. Total height $9\frac{1}{2}$ millims.; of radials $4\frac{1}{2}$ millims.

I propose to name the type *Antedon canaliculata*.

V.—The next form to be considered is *A. complanata*, by which name I distinguish a British-Museum specimen from Nattheim, which consists of the basals and radials only without any centrodorsal attached (Pl. IX. fig. 9). The radials have an external surface nearly as large as that of *A. costata*; and their distal faces slope very much, so that the calyx has a flattened appear-

ance; and nearly the whole of the great dorsal fossa is visible in a view of the calyx from above. The central pit in this fossa is rather less conspicuous than usual. The dorsal surface of the radial pentagon (fig. 9 *b*) is singularly like that of *A. costata* and of the closely related (if not identical) *A. Gresslyi*, Etallon. There are five rod-like basals, which are barely in contact centrally, while their outer ends are just traceable on the exterior of the calyx (Pl. IX. fig. 9 *a*).

Diameter 12 millims.; height 4 millims.

This species has some resemblance to *A. Picteti*, de Loriol, but is more than twice its size, and is from the Middle Jurassic rocks, whereas *A. Picteti* is from the Neocomian.

VI.—We now come to a type which has given rise to a good deal of discussion. Among Goldfuss's figures of *Solanocrinus costatus* (tab. l. fig. 7) there is one (fig. 7 *c*) which does not agree at all either with the other figures or with Goldfuss's text. There are no external basals, and the radials have no outer surfaces, their articular faces rising directly off the centrodorsal, very much as in Quenstedt's specimen represented in Pl. IX. fig. 5. But Goldfuss's specimen had no external basals, which are present in the original of fig. 5. Goldfuss does not seem to have noticed that it scarcely agreed with his definition of *Solanocrinus*; but the peculiarity was observed by d'Orbigny *, who supposed that the radials were absent as well as the basals, as he mistook their articular faces for a part of the centrodorsal. It is difficult to understand this error, as the resemblance of the five articular surfaces to those of the radials of *S. costatus* would almost seem to have been a sufficient guide. It is interesting, however, as showing how complete was the ankylosis of the radials and centrodorsal.

On this specimen d'Orbigny founded a new genus, *Comatulina*, which he defined as follows:—

"Ce sont des Comatules où il manque à la fois au calice les pièces brachiales et basales, où les bras s'articulent immédiatement sans intermédiaires à la pièce centrale pourvue de ramules."

On this subject Pictet remarks:—"M. d'Orbigny a établi un genre *Comatulina* pour des calices dans lesquels les pièces basales et les radiales manqueraient, et les bras s'articuleraient directement à la centrale. Cette description semblerait indiquer un genre bien tranché; mais M. d'Orbigny prend pour type le *S. costatus*, Goldf., qui a évidemment des petites pièces basales."

* *Op. cit.* ii. (i.) p. 139.

In this case Pictet has entirely failed to follow d'Orbigny's meaning. The type of his *Comatulina* is *not* the *S. costatus*, Goldf., although figured under that name in the 'Petrefacta Germaniæ'; for it differs from the type in two important points. Further, d'Orbigny expressly named the individual figure (tab. l. fig. 7, *c*) to which his description referred; and by this means he naturally might be considered to have guarded himself against misapprehension. Messrs. Dujardin and Hupé followed Pictet's lead, speaking of him as "reconnaisant que d'Orbigny qui prenait pour type le *Sol. costatus*, et qui le nommait *Comatulina* lui donnait une caractéristique inexacte en lui refusant à la fois les pièces brachiales et basales et en prétendant que les bras s'articulent, sans intermédiaire, à la pièce centrale."

The last error is easily comprehensible, as I have shown above; while the absence of basals is a fact, though Dujardin and Hupé seem to have recognized no more than Pictet did, that Goldfuss's tab. l. fig. 7 *c* differs from the adjacent figures of *S. costatus* in this essential character.

There are two specimens in the British Museum which are very like the figure in question, one from Nattheim and the other simply labelled "White Jura, Wurtemburg." The former (Pl. IX. fig. 8) is the larger, and has a flatter calyx, *i. e.* the slope of the articular faces is less steep. The central pit for the elastic ligament in the great dorsal fossa is less marked than in the second specimen, which is almost exactly like Goldfuss's figure, except that its centrodorsal is a little lower and less tapering. I do not think, however, that either of these can be considered specifically different from Goldfuss's specimen. At one angle of the Nattheim specimen there is a slight irregularity of growth (Pl. IX. fig. 8 *b*), for the two contiguous radials show a small amount of outer surface which slopes away laterally and disappears rather sooner on one side than on the other. This is an abnormal condition of some interest, from its relation to d'Orbigny's other type, *Decameros*, which will be considered immediately. Figs. 8 *a* and 8 *b* show the other characters of this type, for which I propose the name *Antedon d'Orbignyi*, as d'Orbigny was the first to recognise its peculiarities.

Total height $6\frac{1}{2}$ millims.; of radials 3 millims.

VII.—The Woodwardian Museum contains a specimen from Nattheim of the *Comatulina* type, which differs considerably both from

* *Op. cit.* p. 211.

d'Orbigny's original species and from that just described. The distal faces of the radials have a very steep slope (Pl. IX fig. 7 *b*), so as not to enter very largely into the ventral aspect of the calyx (fig. 7 *a*). The centrodorsal is a thick disk, the sides of which bear several vertical rows of two, or occasionally of three sockets each; but there are none at all on the pentagonal dorsal surface, which is nearly flat.

Diameter $8\frac{1}{2}$ millims. Height $5\frac{1}{2}$ millims.; of radials 3 millims.

I believe this species to be an *Actinometra*, and propose to call it *Act. wurtembergica*. Although the centrodorsal is relatively thicker than it usually is in this genus, it is scarcely more so than in the recent *Act. stelligera* (Pl. XII. fig. 26), while its dorsal surface is entirely free from cirrhi as in the typical forms of the genus. The proportions of the articular faces of the radials, their steepness, and the consequent width of the central funnel are also characteristic of *Actinometra.* They are not quite as steep as in *Act. lineata* from Bahia (Pl. XII. fig. 27 *a*), in which the calyx is remarkably "wall-sided;" but the same is the case with one or two recent species, which are nevertheless undoubted *Actinometræ.*

As with most Jurassic *Comatulæ*, the boundary between the ligamentous and muscular fossæ seems to have been very slightly marked and to have become altogether lost. This feature, which always indicates the small size of the muscular fossæ, together with the relative lowness of the articular faces, is very characteristic of recent *Actinometræ* (Pl. XII. fig. 26); and it is very rare in the recent species of *Antedon.* Almost the only one in which it appears is *Ant. macrocnema*, from Sydney Harbour, which in this, as in other respects, presents so many points of resemblance to the Jurassic *Comatulæ.* The majority of Cretaceous and recent *Antedons* are of a type like that of *Ant. antarctica* (Pl. XII. fig. 29 *a*), with high articular faces and large well-marked muscle-fossæ, which are separated from the ligament-fossæ by a distinct ridge. It is therefore interesting to find most of the earlier *Antedons* approaching *Actinometra* in this respect. There are however, a few exceptions. Thus, in *Ant. Tessoni* (Pl. X. fig. 10), *Ant. decameros* (fig. 11), and *Ant. scrobiculata* (figs. 17 *a*, 18 *a*) the boundary ridge between the ligamentous and muscular fossæ is distinctly visible. De Loriol * has figured it in this last species (pl. xx. figs. 11 *b*, 12 *b*), and also in *Ant. Gresslyi*

* 'Swiss Fossil Crinoids,' *loc. cit.*

(pl. xx. fig. 4 *a*), *Ant. Gillerioni* (pl. xx. fig. 7*b*), and *Ophiocrinus Hyselyi* (pl. xxi. figs. 10 *a*, 10 *b*); but he does not seem to have been aware of its meaning; for he neither mentions it, nor does he ever mention any ligament-fossæ except the large dorsal one below the articular ridge.

VIII.—We now come to a type of *Comatulæ* with which Goldfuss was unacquainted, although it is represented by the Cretaceous species *Hertha mystica*, described by Hagenow * in 1840, and by most recent *Comatulæ*. It was described by d'Orbigny † as follows under the name of *Decameros*:—"Nous reservons ce nom aux Comatules dont le calice se compose d'une pièce centrale épaisse, et sur laquelle s'appliquent immédiatement cinq pièces brachiales, sans pièces basales." In addition to the recent *Antedon* and *Alecto*, two fossil species were referred by d'Orbigny to this type, and *Hertha* was subsequently added by Pictet. But as their nomenclature was incorrect, the classification which they proposed, although a sound one and based on good morphological principles, was never really adopted. Quenstedt, indeed, makes no mention of it except that he regarded forms without external bases as monstrosities of *Ant. costata*. Thus, after describing this species on p. 58 of his 'Jura,' he continues—"Es scheinen auch Missbildungen vorzukommen; der fig. 11 (tab. 88) fehlen z. B. die Zwischenradiale, und die Radialglieder zeigen aussen eine breitere glatte Fläche, aber die poröse Säule bleibt noch." It is strange that he had not only overlooked the descriptions of d'Orbigny and Pictet respecting the deficiency of basals in certain *Comatulæ*, but that he was not then aware that this was the condition of nearly all the recent *Comatulæ* then known (*Comaster*, Goldf., being of course excepted). It seems, however, to be comparatively rare among the fossil species, most of which have the basals more or less developed externally, though they are occasionally wanting at one or two angles of the calyx ‡. There are two specimens in the British Museum which are devoid of external basals, and must therefore be ranked with the *Decameros*

* "Monographie der Rügen'schen Kreide-Versteinerungen. ii. Abtheil. Radiarien und Annulaten," Neues Jahrb. f Mineralog. 1840, p. 664.

† *Op. cit.* ii. p. 138.

‡ E.g. *Ant. æquimarginata*, *A. lenticularis*, *A. canaliculata* (Pl. IX. figs. 6 *a*, 6 *b*). No external basals have been described in *A. italica*, while they do not appear in de Loriol's figures of *A. Picteti*, *A. infracretacea*, and others, though he says they are "à peine apparentes au dehors."

of d'Orbigny. Neither of them is identifiable with Quenstedt's "Missbildung" ('Jura,' tab. 88. fig. 11), while they are also different from one another (Pl. X. figs. 10, 11). The larger one, *Antedon Tessoni* (fig. 10), belongs to the Tesson collection, in which it was received under the name of *Millericrinus regularis*, d'Orb., a somewhat singular name, as d'Orbigny's description* of this species commences "sommet inconnu"! The specimen in question is from the Argile de Dives (Oxford clay) of Vache Noire, and is therefore older than the Nattheim *Comatulæ* from the upper beds of the White Jura. Nevertheless it has a most striking general resemblance to the type of *Antedon costata* (Pl. IX. fig. 1 *a*), except for the radials resting directly on the centrodorsal all round, instead of being cut off from it by basals at the angles. They have a large external surface continuing the upward slope of the centrodorsal, and looking downwards and outwards just as in *Ant. costata*, while the appearance of the ventral aspect of the calyx is very much the same in both species. *Ant. Tessoni* is distinguished, however, by the nature of the articular faces of the radials. These have much more distinct ridges, separating the muscular fossæ above from the ligament-fossæ below, than I have seen in any specimen of *Ant. costata*; while the ligament-fossæ themselves are separated by a groove, proceeding downwards from the intermuscular notch and ending round the opening of the axial canal. These characters alone are sufficient to indicate the specific distinction of this type.

Diameter 12 millims. Height $8\frac{1}{2}$ millims.; radials $4\frac{1}{2}$ millims.

IX.—The smaller "*Decameros*" in the British Museum is from Nattheim, and its ventral aspect much resembles that of *Ant. Tessoni* and *Ant. costata*. But the external surface of the radials (Pl. X. fig. 11) is small, and looks almost directly downwards, as in *Ant. truncata* (Pl. IX. fig. 3). Although I fully believe basals to be wanting at all the angles of the calyx, I cannot speak with absolute certainty about it; for there are some suspicious-looking lines at one angle that might be the sutural lines of a small basal. Were they so, this species would be brought still nearer to *Ant. truncata*, from which, however, it differs altogether in the nature of the articular faces. They are higher in proportion to their width, and have well-developed muscle-fossæ separated distinctly from the ligament-fossæ, as in *Ant. Tessoni*; but the mode of separation is different. In *Ant. Tessoni* the fossæ are separated by a

* 'Crinoïdes,' p. 88

nearly horizontal ridge (Pl. X. fig. 10); but in *Ant. decameros*, as I will call the Nattheim specimen, the ligament-fossæ have a convex upper border (Pl. X. fig. 11), behind and inside which are the muscle-plates. Consequently these stand out much more independently of the ligament-pits than those of *Ant. Tessoni* do.

Diameter $8\frac{1}{2}$ millims. Height $7\frac{1}{2}$ millims.; radials $3\frac{1}{2}$ millims.

X.—The Woodwardian Museum contains three specimens, all from Nattheim, of another small *Antedon*, which differs considerably from either of the species just described. The radial pentagon is much depressed, as in *Ant. complanata* (Pl. IX. fig. 9 *a*), and its external surface slopes rapidly downwards and inwards until it meets the low centrodorsal. The latter is thus of much less diameter than the radial pentagon, especially in the specimen represented in Pl. X. fig. 13. Neither of the three (Pl. X. figs. 12, 13) show external basals; and in this respect they differ from certain somewhat similar forms that have been already described elsewhere. Among these are *Ant. Picteti* and *Ant. infracretacea* of de Loriol, already referred to as having scarcely visible basals. The first of these, from the Étage Valangien of Switzerland, differs from the Woodwardian specimens (*Ant. depressa*) in being a good deal smaller, and in the somewhat different proportions of the radials, though the same general features appear in both. Besides *A. Picteti* has only ten cirrhi or even fewer; while there may be three rows of sockets in *Ant. depressa* (Pl. X. fig. 12). This last has a general resemblance to fig. 35 on Taf. 96 of Quenstedt's 'Encriniden,' which he calls the young of *Ant. costata*; while, except for the absence of basals and of a transverse ridge on the concave lower surface of the centrodorsal, fig. 13 on Pl. X. is not unlike Quenstedt's figures of *Ant. sigillata* (tab. 96. figs. 49, 50). The original has only one row of cirrhus-sockets of the usual *Solanocrinus* character, viz. oval-oblong in shape with a transverse articular ridge pierced by the opening of the cirrhus-canal. There is, however, no distinct indication of this in either of Quenstedt's figures, which may be due either to the imperfect preservation of his specimens or to their immaturity.

Diameter of largest specimen 7 millims. Height $4\frac{1}{2}$ millims.; radials $2\frac{1}{2}$ millims.

XI.—The designation *sigillata* has been given by Quenstedt to those rare specimens which show a perforated articular facet on the lower surface of the centrodorsal, thus retaining, as suggested by him, more or less permanent traces of their larval condition.

These immature Antedons occur at both Nattheim and Schnaitheim in the same beds (Weisser Jura, ϵ) as *A. costata.* I do not think, however, that they can be identified with that species, chiefly on account of the differences in the characters of the radials. A side view of *A. costata* (Pl. IX. figs. 1 *a*, 2 *a*) shows not only the external surface of the radials directly above the centrodorsal, but also their distal articular faces, that are set at a very obtuse angle to this surface. In *Ant. sigillata*, on the other hand, the outer surface of the radials is relatively far larger than in *Ant. costata*; but the distal articular faces, are set on to it at such a much less obtuse angle that little or nothing is visible of them in a side view ('Encriniden,' tab. 96. fig. 49). I know nothing like this condition among the recent *Comatulæ*, though an apparent approximation to it is seen in Quenstedt's figures 35 and 56, described as the "young" of *Ant. costata* and *Ant. scrobiculata* respectively; but these figures are not distinct enough for me to make this out with certainty. They also resemble *Ant. sigillata* in the relatively small size of the basals, which is another point of difference between it and *Ant. costata.* Many of these smaller varieties require much more illustration than it was possible to give them in the necessarily crowded plates of Quenstedt's admirable atlas.

XII.—*Antedon aspera* is one of these incompletely known forms. The calyx seems to be rare, though portions of the arms have been found in the Swiss Jura by de Loriol and others*. It was originally described and figured by Quenstedt in the 'Jura' as *Solanocrinus asper*, its surface being roughened by fine tubercles. The same writer has again figured his original specimen in his 'Encriniden,' giving a different view of it from that represented in his earlier figure. No external basals are present in the latter, and there is no mention of them in the accompanying descriptions. But in the later figure fairly large basals are represented, while Quenstedt also describes and illustrates a tetraradiate form with *five* basals, so that they may be regarded as characteristic of the type. Figures 19 *a*, *b*, *c* on Pl. XI. represent three views of a small specimen from Streitberg (White Jura, α), in the Münster collection of the Woodwardian Museum, that appears to be identical with Quenstedt's species. The centrodorsal is a pentagonal disk with its angles produced into five strong ribs, each of which is marked by a distinct groove. The grooves start from near the

* The literature of this species may be found on p. 257 of de Loriol's 'Crinoïdes Fossiles de la Suisse,' part iii. (1879).

centre of the dorsal surface of the piece, pass over its edge and along the sides towards the ventral surface, but end at different levels (Pl. XI. figs. 19 *a*, *c*). It is very difficult to say whether basals are present or not. There are processes at two of the angles which might be taken for basals (fig. 19 *a*); but these are absent at a third and difficult to make out in the other two. The diameter of the radial pentagon is considerably greater than that of the centrodorsal; its wide outer surface is very rough and uneven. The general shape of the articular faces resembles that of some specimens of *A. scrobiculata* (Pl. X. fig. 18 *a*), but there are one or two peculiar features. The transverse articular ridge present in nearly every *Antedon* is absent, but in place of it a strong process runs from each side towards the middle line and then stops abruptly (Pl. XI. fig. 19 *a*). Just above the inner ends of these two processes is a large transversely oblong hole, which I take to be the central canal; but if so, there is no ligament-pit below it, while both are represented in the later figure of Quenstedt's specimen. A short bony bar bridges over this large opening on the ventral side and unites the two large triangular muscle-plates, the outer edges of which are thick and everted as in *A. scrobiculata*. This gives a peculiar appearance to the ventral surface (Pl. XI. fig. 19 *b*), the furrows between the apposed muscle-plates converging to a large pentagonal opening, which is evidently more or less artificial; its angles correspond with the bony bars above the large openings in the articular faces.

Diameter 6 millims.; height $5\frac{1}{2}$ millims.; radials $3\frac{1}{2}$ millims.

XIII.—Antedon scrobiculata. (Pl. X. figs. 14–18.)

Goldfuss, Quenstedt, and de Loriol* have described under the above specific name a number of *Antedons* from different horizons, which all resemble one another in certain points, but differ very much in others. They all differ from *A. costata* in the distal faces of the radials being higher than wide, the reverse being the case in *A. costata*. The Münster collection of the Woodwardian Museum contains three specimens of this species, two of them authenticated in Münster's own handwriting. One character common to them and to the other known examples of the species is the shape of the central funnel. This is not a simple pentagon,

* 'Swiss Crinoids,' p. 255 (with literature).

as in *A. costata*, but a relatively narrower opening* in the form of a star with five blunt petaloid rays. These rays correspond to the interradial angles of the calyx, where there is no notch between the muscle-plates of adjacent radials; but the upper edge of each plate rises considerably from its inner to its outer margin, where it meets its fellow of the next radial (Pl. X. figs. 17*a*, 18*a*). The edges of the muscle-plates are here somewhat thickened and everted, so as to produce the more or less petaloid figure surrounding the central funnel (fig. 17*b*). The ventral interradial furrows start from the points of the figure and lead down into the interior of the calyx; the ventral radial furrows, on the other hand, start from shallow notches in the re-entering angles of the figure. These notches separate the inner ends of the two muscle-plates of the same radial, but are not continued down on to the articular surfaces, except as very faint grooves.

This eversion of the muscle-plates at the top is especially marked in fig. 15 on tab. 81 of Quenstedt's 'Jura,' and in Pl. X. fig. 18*a*; while it is much less distinct in the specimen, from a different locality and horizon, represented in fig. 34 on tab. 51 of the 'Petrefactenkunde,' so that the opening of the central funnel is more nearly pentagonal and less distinctly stellate. In this specimen, too, the basals are smaller than usual, though there is a considerable range of variation in this respect†. In some forms they project prominently beyond the level of the radials, the so-called *Solanocrinus Bronnii* of Münster‡ showing this most distinctly (Pl. X. fig. 16). I am disposed to follow Quenstedt's example and to merge this species in *A. scrobiculata*, the range of variation in which renders the isolation of Münster's species rather difficult.

The numerous varietal forms which have been referred to *A. scrobiculata* (and all agree in the characters already mentioned) differ very considerably in the appearance of the outer surface of the radials and in the shape of the centrodorsal. Thus, one of Goldfuss's specimens (Pl. X. fig. 14) had a very deep centrodorsal, with the high outer surfaces of the radials much narrowed below by the large size of the basals. But a Woodwardian specimen with a similarly deep centrodorsal has a calyx with characters intermediate between those of Goldfuss's two varieties

* The opening of the original of fig. 17 *b* is both wider and more pentagonal than usual.

† Compare figs. 15–17, 19 & 21 on Plates X. and XI.

‡ Beiträge zur Petrefactenkunde, p. 101, Taf. xi. fig. 7.

represented on Pl. X. figs. 14, 15. On the other hand, the centrodorsal may be exceedingly shallow and the exterior of the radials very low, as in the Woodwardian specimen shown in Pl. X. fig. 17*a*, and in some of the forms from the Swiss Jura figured by de Loriol. In tab. 96. figs. 52–55 of his 'Encriniden,' Quenstedt represents four different calices that are all alike in their general features, but differ in minor points, such as the height of the outer surface of the radials and the relative prominence of the basals. The centrodorsal is of much the same size and shape in all of them, in no case reaching the length shown in Pl. X. fig. 14, while it is never so small as in the original of Pl. X. fig. 17*a*. The total height of this specimen is 7 millims., that of the radials 5 millims., and its diameter 8 millims.; while in the other perfect (Woodwardian) specimen already mentioned, with slightly smaller radials, the depth of the centrodorsal is doubled, viz. 4 millims. instead of only 2 millims.

A. scrobiculata differs considerably from *A. costata* in the size and disposition of its basals, which Quenstedt* has well described as follows:—"Man findet auf den untern Kelchflächen (tab. 96. fig. 57) fünf nach den Ecken strahlende Rinnen, welche die Unterseite der Basalia bilden, die sich um den grossen Nahrungskanal zur einer Fläche ausbreiten und so eine festere Unterlage der Radialglieder bilden. Die Fläche ist bald eben (fig. 57), bald ansehnlich vertieft (fig. 58)." A comparison of the side and dorsal views of the radial pentagon, as represented in figs. 18*a* and 18*b*, gives a very good idea of the basals as prismatic rods, the dorsal surface of which is almost entirely occupied by a groove with plaited sides. But the actual basal pieces themselves are rather wider than these grooves, which does not appear in Quenstedt's description of them, though it is just traceable in his figures. This is seen still more clearly in the basals of *Act. cheltonensis* (Pl. XI. fig. 20*b*), which have far more distinctly plaited grooves than those of *Ant. scrobiculata*. Both these last-mentioned species differ from *Ant. costata* in the confluence of the inner ends of the basals, so as completely to separate the radials and centrodorsals for some little way round the opening of the central funnel. In *Ant. costata*, however, the central ends of the basals do not seem to meet one another at all†, while the same might be said of *Ant. complanata* (Pl. IX. fig. 9*b*).

* Encriniden, p. 179.

† Encriniden, tab. 96. figs. 29, 44.

XIV.—Actinometra cheltonensis, n. sp. (Pl. XI. fig. 20.)

This fossil consists of the united radials and basals of what must have been a very large *Actinometra*. The five basals are united by their broader inner ends, so as to conceal the central half of the radial pentagon (fig. 20*b*). A deep linear-oval groove is excavated along the underside of each of them, terminating just short of the rounded end which appears externally (fig. 20*a*). The sides of the groove are marked by very distinct cross ridges and furrows, which do not quite reach either end of it. The outer portion of the dorsal surface of the radials (*i. e.* that portion which would have appeared externally when the centrodorsal was *in situ*) is rather narrow, and looks almost entirely downwards. Hence, although it appears on the dorsal aspect of the calyx outside a line drawn round the points of the basal star (fig. 20*b*), but little of it is seen in a side view (fig. 20*a*), except where its flanks are turned upwards above the rounded ends of the basals. The articular faces are trapezoidal in shape, and the pit in the great dorsal fossa, which lodged the chief mass of the elastic ligament, is unusually long and narrow, somewhat as in *Ant. Gillerioni*, de Loriol. The transverse articular ridge above it is rather large, and the opening of the central canal which pierces it much elongated transversely, and also slightly constricted in the centre. This indicates that the secondary basal canals, by the union of which the axial canal of each ray is formed, did not in this species converge quite so rapidly as in other *Comatulæ*; so that it presents a slight approach to the condition found in *Encrinus*, in which genus they do not unite in the first radial at all, but open by two separate apertures on its distal face. The muscle-plates are rather small, and separated by a wide but shallow notch; they are marked off from the ligament-fossæ by faint cross ridges, which run inwards from the sides, and then turn downwards towards the rim of the opening of the axial canal, so as to leave a slight groove between them (fig. 20*b*).

Diameter 9 millims.; height 3 millims.

Locality. The Inferior Oolite, Cheltenham.

Remarks. This specimen was found by the Rev. P. B. Brodie, M.A., F.G.S., who has kindly placed it in my hands for description. The relative width of the articular faces and the condition of the muscle- and ligament-fossæ indicate this type as an *Actinometra*, though the articular faces are more sloping than in most species of the genus. There are, however, one or two similarly aberrant species in the 'Challenger' collection.

Act. cheltonensis is interesting as being one of the two oldest known *Comatulæ*, so that *Act. Mülleri*, of the Bath Oolite, must be disestablished. Since describing this species* I have obtained some information respecting the "*Solanocrinus*" mentioned by Mr. Charles Moore, F.G.S., in the 'Geological Magazine' for 1875. This fossil was found by Mr. Moore in the Inferior Oolite at Dundry, and is an unmistakable *Antedon*, as I have learnt from a drawing of it which he kindly sent me. It is quite a different type from *Act. cheltonensis*, having high radials more like those of *Ant. antarctica* (Pl. XII. fig. 29*a*). It is very interesting to find that while most of the Jurassic *Comatulæ* are rather synthetic in their character, the two genera *Antedon* and *Actinometra* were yet distinctly differentiated at the earliest period at which we have any record of their appearance.

XV.—We have now to consider an interesting fossil that was figured by Goldfuss† under the name of *Solanocrinus Jaegeri*. He describes it as resembling *S. scrobiculata* in external form, but as differing essentially, " durch seine Beckenglieder, welche so breit sind dass sie auf der ganzen Gelenkfläche zusammenstossen, und hier fünf ausstrahlenden Furchen zur Aufnahme der Säule bilden. Die Säule ist nicht bekannt." Figures 24, *a*, *b*, & *c*, on Pl. XI., are copied from Goldfuss's representations of this very elegant type, the difference between which and the *Comatulæ* represented by him (Pl. IX. fig. 1, Pl. X. figs. 14, 15) is self-evident. In the latter the basals are small and not in contact with their fellows for the whole length of their sides; whereas in *S. Jaegeri* they form a completely closed ring beneath the radials (figs. 24, *a*, *c*). This was recognized by Pictet ‡, who suggested that *S. Jaegeri* should be removed from *Solanocrinus*, as typified by *S. costatus* with small basals, and that it should be placed in a separate genus (*Comatula*), which he had defined as follows:—"Les *Comatula*, Lamarck (*Astrocoma*, Blainv.), ont les bras bifurqués une ou deux fois. Le calice est composé d'une pièce centrale, de cinq petites pièces basales et de cinq brachiales qui alternent avec les basales. Il porte dix séries de ramules égales."

This classification is a very singular one. Lamarck's name *Comatula* had been already adopted by d'Orbigny for the *Solanocrinus* group characterized by the presence of external basals. These are not present in any of Lamarck's original specimens,

* Quart. Journ. Geol. Soc. vol. xxxvi. p. 54.

† *Op. cit.* p. 168, Taf. l. fig. 9.

‡ *Op. cit.* p. 288.

while no recent *Comatulæ* are known with a complete basal circlet like that of *S. Jaegeri*. According to Pictet's proposed classification, therefore, the name originally established by Lamarck for several recent forms without any external basals would have passed to a single fossil specimen that I shall show directly to be the head of a *Pentacrinus*, and not a *Comatula* at all!

Schlüter speaks of it as abnormal, and not belonging to the type of *S. costatus* and *S. scrobiculatus*, but does not offer any opinion as to its real nature. This, however, is discussed by Quenstedt, though with a singularly unfortunate result. A small specimen from Nattheim was referred by him to this species and described, with figures, no less than three times. It was first noticed in the 'Petrefactenkunde' (p. 717), with the remark that the basals were scarcely visible (!), and that the lowest part consisted of a large smooth stem-joint (Pl. XI. fig. 22). His figure (tab. 51. fig. 33) shows no basals between this stem-joint and the radials, although in Goldfuss's specimen they were quite large (Pl. XI. fig. 24, *a*, *c*). The figure in the 'Jura,' however (tab. 88. fig. 12), shows small points in this position (Pl. XI. fig. 22 *a*); while Quenstedt seems to have recognized their want of resemblance to the basals of Goldfuss's original specimen; for he states (p. 723) that the smooth stem-joint below them had been regarded by Goldfuss as composed of five anchylosed basals. The figure given in the 'Jura' is reproduced in the 'Encriniden' (tab. 96. fig. 51), with the remark, "Zwar weicht die Goldfuss'che Zeichnung vielleicht nicht unwesentlich ab, allein die Hilfsarme fehlen ihr auch, und das genügte mir um nicht immer gleich wieder neue Namen zu schöpfen." Quenstedt, therefore, while recognizing the difference between his specimen and the *S. Jaegeri* of Goldfuss, seems to have thought the absence of cirrhi from both of them a sufficient reason for not separating them specifically. I shall show, however, that they are not only specifically but also generically different. The distinctive character of Goldfuss's type was the lateral union of the basals to form a complete ring beneath the radial pentagon. This was especially noticed by him, and fully illustrated by his excellent figures (Pl. XI. fig. 24, *a*, *c*), in which the sutures on the outside of the calyx between the individual basals are as distinct as they can well be. The basiradial suture is an obtuse angle, while the radials have a high outer dorsal surface and a high articular face with large muscle-plates, somewhat as in *Ant. scrobiculata* (Pl. X. figs. 14, 15, 17 *a*, 18 *a*), as remarked by Goldfuss. On the other hand,

the radials of Quenstedt's specimen, as he himself admits, are very similar to those of *Ant. costata.* The articular faces are very low (Pl. X. fig. 22 *a*) with small muscle-plates, while the outer dorsal surface is smaller than in *S. Jaegeri*; its lower margin is not angular but only slightly curved, and it is interrupted at the interradial angles by the small points that Quenstedt regards as basals. The radials of Quenstedt's specimen rest upon what he rightly interpreted as a "large smooth stem-joint;" and he supposes Goldfuss to have taken this for the anchylosed basals. This is certainly rather hard on Goldfuss, considering that he never saw Quenstedt's specimen at all, his own type differing considerably from that figured by Quenstedt *.

It appears to me that while Quenstedt was undoubtedly right in supposing his specimen to have been detached from a stem, Schlüter's suggestion as to its being an immature form like *Ant. sigillata* is scarcely a satisfactory one. In the first place, as expressly remarked by Quenstedt, there are no certain traces of its having borne cirrhi, as would assuredly be the case were it a young and immature *Comatula.* On the other hand, if we suppose that cirrhi were once present, but that the centrodorsal has lost all traces of their sockets by the progressive deposit of new material upon its external surface, we are met by another difficulty. If this deposit has taken place it has been limited to the sides of the centrodorsal, which are usually the last parts to be affected by it, and it has not even closed up the central perforation, which in recent *Comatulæ* is obliterated very soon after the loss of the larval stem, the superficial deposit commencing here and gradually extending outwards.

The absence of cirrhi, together with the presence of a perforated articular facet on the under surface of Quenstedt's specimen (Pl. XI. fig. 22, *a*, *b*), seem to me to indicate clearly that it is the head and top stem-joint of a stalked Crinoid. There are some closely similar specimens in the British Museum, in which the presence of basals externally is very doubtful, as it is in the one figured by Quenstedt. I am inclined to think that these, as well as Quenstedt's specimen, should be referred to Étallon's genus *Thiolliericrinus*, good figures of which are given by de Loriol †. At any rate, they are not *Comatulæ.*

* Since the above lines were written, I have seen Goldfuss's original specimen of *S. Jaegeri* in the magnificent palæontological collection at Munich, and have satisfied myself as to the accuracy of his figures and description of it.

† Swiss Fossil Crinoids, pl. xviii. figs. 8, 9.

XVI.—The same may be said of the "*Solanocrinus Jaegeri*" of Goldfuss, which is nothing but the calyx of a *Pentacrinus* detached from its stem. This will be evident from a comparison of figs. 23 & 24 on Pl. XI. The three figures 24, *a*, *b*, & *c*, are reproductions of Goldfuss's figures of *S. Jaegeri*; while figs. 23, *a*, *b*, *c*, which Dr. Carpenter has kindly permitted me to publish, represent the corresponding parts of *Pentacrinus Wyville-Thomsoni*, dredged by H.M.S. 'Porcupine' in 800 fms. off the coast of Portugal in 1870. This species has a complete basal circlet, as also have *P. Mülleri*, Lütken*, and *P. Maclearanus* of the 'Challenger' dredgings. On our present classification both of these should be referred to *Cainocrinus*. This genus was established by Edward Forbes† for the reception of a small form from the London Clay, which resembles the well-known *P. briareus* and *P. asteria* (Pl. XI. fig. 21) in all essential points except the possession of a complete basal circlet. The distinction has been retained and made more precise by de Loriol‡, probably in ignorance of the existence of two recent species of *Cainocrinus*. He defines *Pentacrinus* as differing from *Millericrinus* in having very small basals, which do not meet externally, and in the verticillar arrangement of the cirrhi. On the other hand, *Cainocrinus* has a complete ring of basals like *Millericrinus*, but a stem with verticils of cirrhi like *Pentacrinus*. I cannot, however, regard this classification as satisfactory; for even in those species of *Pentacrinus* which have an incomplete basal ring there is a great amount of variation in the extent to which the central ends of the basals are joined, and in the size of their outer ends which appear between the radials and the top stem-joint. The basals are least developed in *P. asteria* (Pl. XI. fig. 21), but there are all sorts of gradation between this condition and that of *P. Wyville-Thomsoni* and of the fossil *Cainocrinus*. A closed basal circlet occurs in the fossil *P. Sigmaringensis*, Quenstedt§, referred by de Loriol to *Cainocrinus*, in *P. pentagonalis ferratus*‖, and in the unnamed specimen¶ from Solzenhausen, in which Quenstedt specially describes a closed basal circlet. He does not see any essential difference between *Cainocrinus* and *Pentacrinus*, and

* "Om Vestindiens Pentacriner," Videnskabelige Meddelelser fra den Naturhistoriske Forening i Kjöbenhavn, 1864, tab. iv., v.

† British Tertiary Echinoderms, p. 33.

‡ Swiss Fossil Crinoids, pp. 111, 112.

§ Encriniden, tab. 99. fig. 132.

‖ Ibid. tab. 98. fig. 135.

¶ Ibid. p. 263, tab. 99. fig. 174.

therefore drops the former altogether. But he goes even further, as I do also, and includes in *Pentacrinus* all those forms which otherwise agree with the type but have no visible basals. One, for example, is the *P. cingulatus*, Quenstedt, = *Isocrinus pendulus*, Meyer*. Another is the Forest-Marble specimen from Farley in Wiltshire, which was described by Goldfuss as *P. scalaris*. A third is the large Chalk *Pentacrinus* belonging to Mr. Willett's collection, which is figured in Dixon's 'Geology of Sussex' (1878 edition, pl. xix. 22). Another is the *P. pentagonalis personatus* from the Brown Jura, which is figured by Quenstedt (tab. 98. fig. 137) without any notice of its peculiarities. Lastly, there comes *P. Fisheri*, in which basals were described by Baily†. They are really, however, nothing but the first radials, the basals being absent from the exterior of the calyx. It might be thought that all these species without external basals should be separated from *Pentacrinus* and placed in the genus *Isocrinus*, von Meyer. In this way we should be making three genera out of one type, according as the basals are invisible externally (*Isocrinus*), or form an incomplete (*Pentacrinus*) or a complete ring (*Cainocrinus*). I do not think, however, that such a classification would be a sound one. On the same principle we should have to found a new genus for *Encrinus Cassianus*‡, in which "der perlschnurförmige Stiel deckt die tief eingesenkte Basis so stark, dass erst bei der genauesten Reinigung 5 winzige Dreiecke zum Vorschein kommen." Yet another new genus would be necessary for the reception of the tetramerous variety of *E. liliiformis* represented in tab. 107. fig. 5 of the 'Encriniden.' It has no external basals at all, but the radials rest directly on the top stem-joint. In the same way those forms of *Bourgueticrinus*§ in which the basal ring is incomplete, as in *Pent. asteria*, should be separated generically from the ordinary forms with a closed basal ring.

Seeing, then, that we have such a complete series from *P. Fisheri* and its allies through *P. asteria* (Pl. XI. fig. 21), *P. briareus*, and *P. decorus* to *P. Wyville-Thomsoni* (Pl. XI. fig. 23), *P. Jaegeri* (Pl. XI. fig. 24), and *P. Sigmaringensis*, a separation of either of the extremes from the rest of the series seems to me

* "*Isocrinus* und *Chelocrinus*," Museum Senckenbergianum (Frankfurt, 1837).

† "Description of a new Pentacrinite from the Kimmeridge [*cf.* Oxford] Clay of Weymouth, Dorsetshire," Ann. & Mag. Nat. Hist. ser. 3, vol. vi. pp. 25–28, pl. i.

‡ Encriniden, p. 472.

§ *Actinometra*, p. 108, Trans. Linn. Soc. 2nd ser. Zoology, vol. ii.

a mistake, especially if we consider the corresponding conditions of *Bourgueticrinus*, *Encrinus*, and of *Comatula*. In the latter group basals may appear externally at some angles of the calyx and not at others. This is the case, for example, in *Ant. canaliculata* (Pl. IX. figs. 6, *a*, *b*) and in *Ant. complanata* (figs. 9 *a*, 9 *b*), in the latter of which the basals are somewhat similar to those of *P. asteria* (Pl. XI. figs. 21, *a*, *b*). Unfortunately we know of no *Comatula* with *Pentacrinus*-like basals which yet do not appear externally. But this is probably only because a view of the under-face of the calyx is so rarely obtained. If this face could be exposed in any specimens of d'Orbigny's *Comatulina* or *Decameros* (Pl. IX. figs. 7, 8, and Pl. X. figs. 10–12), it would doubtless be found that the basals were like those of *Ant. complanata* (Pl. IX. fig. 9) and *P. asteria* (Pl. XI. fig. 21), only rather shorter and not appearing externally as in these species. This is possibly the case in some of the species figured by de Loriol. I imagine it to be also the case in *Isocrinus pendulus*, *P. Fisheri*, and the other forms with no external basals, though it is, of course, possible that their basals may have undergone transformation into a rosette, as in recent *Comatulæ*. But this seems to me very unlikely. All the evidence we have goes to show that the basals of the Jurassic *Comatulæ* persisted, as in recent *Pentacrini*, without undergoing transformation into a rosette, and it is improbable therefore that this transformation should have occurred in extinct species of *Pentacrinus*.

It would be very interesting to determine, were it only possible, how and when the *Comatula*-stock first began to develope a rosette. As to *Ant. costata*, *Ant. scrobiculata*, and *Act. cheltonensis*, there can, I think, be little doubt that their basals are the embryonic ones. In the latter species there is obviously no rosette (Pl. XI. fig. 20 *b*), and the same applies to *Ant. scrobiculata* (Pl. X. fig. 18 *b*), in which the margins of the under surfaces of the basals are faintly plaited. This feature is more marked in a specimen in the British Museum figured in König's ‘Icones’ as *Symphytocrinus florifer*, in obvious reference to the petaloid figure formed by its basals, which expand rather more between their inner and outer ends than do the corresponding parts of the Cambridge specimen. It forcibly recalls the plaiting on the underside of the basals of *Pentacrinus*, which may be almost separate (Pl. XI. fig. 21 *b*), completely united (figs. 23, 24), or in an intermediate condition like those of *Ant. scrobiculata* (Pl. X. fig. 18 *b*) and *Act. cheltonensis* (Pl. XI. fig. 20 *b*). We may therefore, I think, consider

it certain that the external basals of these Jurassic *Comatulæ* are homologous with those of the larval *Antedon* and of *Pentacrinus*; and I have given reasons above for believing the same to be the case with the forms described as *Decameros* and *Comatulina* by d'Orbigny.

In some, at any rate, of the Cretaceous *Comatulæ* the larval basals appear to have persisted without metamorphosis. In one fortunate case (Pl. XII. fig. 30, *a*, *b*) a single basal has been preserved, adhering to the centrodorsal piece; and though its outer end is quite inconspicuous, it is relatively larger than the outer end of the basal ray in either of the recent species represented in Pl. XII. There are various other Cretaceous species with larger or smaller basals; but there are also a few of the *Decameros* type without external basals, such as *Hertha* (*Antedon*) *mystica* and *Act. Lovéni.* The latter species has such a striking resemblance to recent *Actinometræ* that I suspect it had a rosette; and the same may perhaps have been the case with *Ant. mystica* and with the two Tertiary species *Ant. italica* and *Ant. alticeps.* These are the only Tertiary *Comatulæ* of which the calyx is known; but they may, of course, have had concealed *Pentacrinus*-like basals and no rosette.

In all recent *Comatulæ* (*Comaster* perhaps excepted) the basals which appear externally are not the embryonic basals at all, but only additional elements in the calyx*, which become connected with the central rosette produced by the metamorphosis of the embryonic basals. Pl. XII. contains some figures of the calices of a few recent *Comatulæ*, to show these basal rays and their connexion with the rosette. They are very well seen in *Ant. macrocnema* from Sydney Harbour (Pl. XII. fig. 25 *c*), which has more resemblance to the Jurassic *Ant. costata* (Pl. IX. figs. 1, 2) than any other recent species. A comparison of fig. 25 *c* on Pl. XII. with fig. 9 *b* on Pl. IX. and fig. 21 *b* on Pl. XI. will show the points of resemblance and difference between the rosette and its appendages in recent *Comatulæ* and the (probably) unmetamorphosed basals of *Pentacrinus* and of fossil *Comatulæ*. Fig. 29 *b* on Pl. XII. shows the corresponding parts of *Ant. antarctica*, in which the basal rays only just appear externally (fig. 29 *a*). The same is the case in the large *Actinometra* represented in fig. 26, and in the smaller *Act. lineata*, shown in figs. 27 *a* and 27 *b*. These two last figures are very instructive. Fig. 27 *b* is a view of the calyx from above after removal of three of the

* *Actinometra*, pp. 96–104.

radials and of one basal ray. The two remaining radials have almost horizontal ventral faces, with the usual radial and interradial furrows. In the centre is seen the rosette from which one basal ray extends N.E.-wards, with a shallow excavation at its central end. Its fellow pointing N. has been removed so as to expose the basal groove of the centrodorsal, in which it was received. The side view (fig. 27 *a*) should be compared with Pl. IX. fig. 6 *c*. The different positions of the articular surfaces of the radials in *Antedon* and *Actinometra* respectively are then well seen. In the former they are inclined at a considerable angle (fig. 6 *c*), whereas in the latter they are generally nearly or quite vertical, as in fig. 27 *a*. Both figures also show the descent of the ventral interradial furrows into the interior of the calyx. In *Act. lineata* (fig. 27 *a*) they end blindly in the excavated central ends of the basal rays*. These parts have a singular resemblance to the basals of *Ant. canaliculata* (fig. 6 *c*); but I believe the resemblance to be one of analogy only, and not of homology. If the basals of *Ant. canaliculata* are what I imagine them to be, viz. the original unmetamorphosed embryonic basals, they are homologous, not with the basal rays, but with the central rosette of *Act. lineata*, which is absent in *Ant. canaliculata*.

All the above-mentioned figures of recent *Comatulæ* are essentially similar to those on plates IV.–VI. of my *Actinometra* memoir. Fig. 28, however, represents the calyx of a new and very interesting type, *Promachocrinus*, the chief novelty among the 'Challenger' *Comatulæ*. It has ten radials instead of only five; but there is no corresponding duplication of the rays of the basal star. Only five rays extend outwards from the central rosette to appear externally beneath five of the radials, and they must therefore be regarded as representing the primary interradii of the type. Hence those radial pieces which are not separated from the centrodorsal by basal rays are the original embryonic radials, homologous with those of the other Crinoids and of the five-rayed Starfishes. The five others may perhaps be compared to the additional radials developed in many-armed Starfishes, in which, however, the positions of the five primary rays are not indicated in the adult as they are in *Promachocrinus*.

The conclusions to which we have been led may be summed up as follows:—

1. In all the Jurassic and in some, at any rate, of the Creta-

* Compare *Actinometra*, pp. 97–103.

ceous *Comatulæ*, the basals are the embryonic basals which have undergone no further modification than those of many *Pentacrinus* species. Their relative size is reduced, as they do not quite separate the radials from the top stem-joint, even when they appear externally, which is not always the case, both individuals and species varying greatly in this respect.

2. In all the recent *Comatulæ* (possibly also in the Tertiary and in some Cretaceous species) the embryonic basals undergo an extensive modification resulting in the formation of a rosette. In many cases basal rays extend outwards from this and may appear externally; but they are only analogous and not in any way homologous to the true basals of the older *Comatulæ*.

3. Most *Pentacrini* have a more or less complete circlet of basals separating the top stem-joint, either partially or wholly, from the radial pentagon. But in some few fossil forms there are no external basals, as may be also the case in *Encrinus*. There is thus a parallel variation to that occurring in *Comatula*, but with a different range, for we know of no *Comatula* (recent or fossil) in which the basal circlet is complete, and of no recent *Pentacrinus* in which no basals appear externally.

4. The variations in the development of the basals are useless as generic distinctions. *P. Fisheri*, *P. briareus*, and *P. Sigmaringensis* among the fossil forms, with the recent *P. asteria* and *P. Wyville-Thomsoni*, are all equally good species of *Pentacrinus*. In the same way *Ant. costata* with small basals, *Ant. scrobiculata* with large ones, and *Comatulina* or *Decameros* with none visible externally are just as good species of *Antedon* as *Ant. rosacea*, which has only a rosette, and *Ant. macrocnema*, which has basal rays as well.

Schlüter, therefore, was perfectly justified in uniting *Solanocrinus* with *Antedon*. He does the same with *Comaster*, though from Goldfuss's description of this type it appears to me to differ so much from all other *Comatulæ* that I prefer, for the present, at any rate, to regard it as generically distinct from the other *Comatulæ**.

In conclusion, I desire to record my obligations to Prof. Hughes, and to Dr. H. Woodward, F.R.S., and Mr. R. Etheridge, jun., for the readiness with which they have permitted me to examine specimens in the Woodwardian and British Museums

* See Journ. Linn. Soc. Zool. vol. xiii. pp. 454–456.

respectively. I am also greatly indebted to the Rev. P. B. Brodie, M.A., F.G.S., who kindly sent me *Act. cheltonensis* for description; and I take this opportunity of expressing my thanks to all these gentlemen.

EXPLANATION OF THE PLATES.

Plate IX.

Figs. 1 and 2, *Ant. costata* = *Solanocrinus costatus*, Goldf., from Nattheim. *a*, from the side; *b*, from above.

Fig. 1. Copied from Goldfuss.

Fig. 2. From a specimen in the Woodwardian Museum, ×2.

Fig. 3. *Ant. truncata*, n. sp., from Nattheim; side view, ×4. British Museum.

Figs. 4 and 5. Different forms of *Ant. costata* (?), Quenstedt ('Der Jura,' pl. 88. figs. 9, 10).

Fig. 6. *Ant. canaliculata*, n. sp., from Nattheim, ×2. *a*, *b*, side views of exterior of calyx (*a* without, and *b* with an external basal); *c*, side view of interior, two radials having been removed. British Museum.

7. *Act. wurtembergica*, n. sp., from Nattheim, ×2. *a*, from side; *b*, from above. Woodwardian Museum.

8. *Ant. d'Orbignyi*, n. sp., from Nattheim, ×3. Side views:—*a*, radials showing no outer dorsal surface; *b*, dorsal surface of radials turned up at the angle of the calyx so as to appear externally. British Museum.

9. *Ant. complanata*, n. sp., from Nattheim, ×3. Radials and basals only: *a*, from side; *b*, from beneath. British Museum.

Plate X.

Fig. 10. *Ant. Tessoni*, n. sp., from side, ×3. Argile de Dives, Vache Noire, France. British Museum.

11. *Ant. decameros*, n. sp., from side, ×3. White Jura, ε, Nattheim. British Museum.

Figs. 12, 13. *Ant. depressa*, n. sp., from Nattheim.

Fig. 12. Side view, ×4.

Fig. 13. Another specimen, seen from dorsal side, ×5.

14–18. *Ant. scrobiculata* = *Solanocrinus scrobiculatus*, Goldf.

Figs. 14, 15. Side views of two specimens, copied from Goldfuss.

Fig. 16. Copy of Münster's figure of a specimen described by him as *S. Bronnii*, but referred by Quenstedt to *S. scrobiculatus*.

Figs. 17, 18. Two specimens from Streitberg, in the Woodwardian Museum, ×4. Fig. 17, *a*, from above; *b*, from side. Fig. 18. Radials and basals only: *a*, from side; *b*, from beneath.

Plate XI.

Fig. 19. *Ant. aspera*, Quenstedt, sp. White Jura and Streitberg. *a*, from the side; *b*, from above; *c*, from beneath: ×4. Woodwardian Museum.

Fig. 20. *Act. cheltonensis*, n. sp. Inferior Oolite, Cheltenham. Radials and basals only, ×4: *a*, from the side; *b*, from beneath.

21. *Pentacrinus asteria.* From Barbadoes. Calyx, ×4: *a*, from side; *b*, from beneath.

22. *Solanocrinus Jaegeri*, Quenstedt. *a*, from side; *b*, from beneath. Copied from Quenstedt.

23. *Pentacrinus Wyville-Thomsoni.* North Atlantic. Calyx, ×3: *a*, from side; *b*, from above; *c*, from beneath.

24. *Pentacrinus Jaegeri* = *Solanocrinus Jaegeri*, Goldf.: *a*, from side; *b*, from above; *c*, from beneath. Copied from Goldfuss.

PLATE XII.

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Fig. 25. *Ant. macrocnema.* Sydney Harbour. Calyx, ×6: *a*, from side; *b*, from above; *c*, radials and basals from beneath.

26. *Act. stelligera*, n. sp. Pacific (Stat. 174). Calyx from side, ×6.

27. *Act. lineata*, n. sp. Bahia. Centrodorsal with two radials, rosette, and part of basal star, × : 6*a*, side view of interior of calyx; *b*, the same, seen from above.

28. *Promachocrinus kerguelensis*, n. sp. Balfour Bay, Kerguelen. Calyx from side, ×6.

29. *Ant. antarctica*, n. sp. Heard Island. *a*, calyx from side; *b*, radials and basals from below: ×6.

30. *Ant. Lundgreni.* From the Upper Chalk, Margate. Centrodorsal with one basal attached, ×3: *a*, from side; *b*, from above.

MOLLUSCA OF H.M.S. 'CHALLENGER' EXPEDITION.—Part VI. By the Rev. ROBERT BOOG WATSON, B.A., F.R.S.E., F.L.S., &c.

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[Read April 15, 1880.]

TURRITELLIDÆ, n. sp.

1. TURRITELLA RUNCINATA.
2. —— ACCISA.
3. —— CARLOTTÆ.
4. —— PHILIPPENSIS.
5. —— CORDISMEI.
6. TURRITELLA AUSTRINA.
7. —— DELICIOSA.
8. —— (TORCULA) ADMIRABILIS.
9. —— (TORCULA) LAMELLOSA.

The genus *Turritella* is a group well defined, as regards the shell, the animal, and the operculum; nor is it unmanageably large. There is therefore no *primâ facie* reason for breaking it up as Gray has done; and his destructive process has not justified itself in the characters of the genera he proposed, which are

neither strongly marked nor constant. The consequence is that the lists of species arranged under *Turritella* (with subgen. *Haustator*), *Torcula*, and *Zaria* are arbitrary in the extreme; and these divisions only cause confusion.

There are two remarkable features of *Turritella* which do not seem to have been noticed. The first is the system of microscopic spirals which covers the entire shell, and which I have found on every even fairly preserved specimen which I have examined. The second is the presence of an epidermis. This is very distinctly recognizable in *T. carlottæ* and in *T. austrina*, and somewhat doubtfully in *T. admirabilis*. It is filmy, calcareous, and in drying seems to contract, so as to rise off the surface of the shell in the furrows, remaining attached only on the tops of the spirals and in the suture. It also splits in the lines of growth. All this renders it of course very caducous; and, as Mr. E. Smith remarks, "the fact of all *Turritellas* appearing to be devoid of an epidermis is quite comprehensible, seeing how excessively thin it is in this instance" (*i. e.* of *T. carlottæ*). Hardly sufficient importance seems generally given to the sinuation of the outer lip, which is a feature quite as distinctly marked as in *Pleurotoma*.

1. Turritella runcinata, n. sp.

St. 162. Ap. 2, 1874. 39° 10′ 30″ S., 146° 37′ E. S.E. Australia, off East Moncœur Island, Bass Strait, 38–40 fathoms. Sand.

Shell broadly conical, a little rounded at the basal angle and on the base, with a distinct suture and a deep labial sinus, thinnish, translucent, and speckled. *Sculpture.* Longitudinals—the surface is closely covered with very fine and strongly curved lines of growth, which on the base are stonger and radiate very straight, but interruptedly, out from the centre. Spirals—there are on each whorl two strongish, but rounded and somewhat ill-defined, carinations: of these, the lower and stronger lies about one fifth of the whorl's height above the suture; the upper and less definite lies a little more than halfway between the lower carina and the superior suture: between these two carinas, but nearer the upper one, lies a thread with almost enough of prominence to form a third carina, and this one sometimes supersedes the upper carina altogether. Besides these, the whole surface is sharply fretted with fine, rounded, unequal, irregular, interrupted, spiral threads, of which a considerable number are stronger than the rest, espe-

cially those toward the base of the whorls are so. The microscopic spiral frettings, which are distinct from these and very much more minute, are present, but want sharpness. The upper whorls are smooth and polished. *Colour* yellowish, more or less tinged and speckled with brown and white. The white is strongest toward the top of the whorls and is in suffused patches; the brown, which also occurs in suffused patches, is prettily dotted in minute specks on the spiral threads. The colour pales on the upper whorls; but the apex is yellow. *Spire* very perfectly conical, though the contour-lines are interrupted by the projection of the inferior carina and by the impression of the suture. *Apex* very fine and small, but rounded, the extreme tip being a little depressed on one side and the first whorl towards its end projecting a very little beyond the second. *Whorls* 15, almost flat, with a constriction between the two carinas, narrowed gradually upwards, but more quickly into the inferior suture, roundly angulated at the basal edge, with a flattish base which is but feebly conical. The last four or five whorls are higher proportionally than the earlier, which are of very slow and gradual increase; the first two are markedly smaller than those which follow; all the earlier whorls are distinctly convex. *Suture* fine, but distinct. *Mouth* rather small, almost square, but a little higher than it is broad. *Outer lip* very straight, roundly angulated below, patulous and almost canaliculate at the pillar-point; it advances a good deal at its junction with the preceding whorl, from which point it retreats so as to form a very deep and narrow sinus, the upper edge of which lies along the upper carina, and whose apex occupies the depression between the upper and lower carina. The lower edge of this sinus advances in a line much more oblique than its upper edge, which is almost parallel to the suture; it is the deep curve of this sinus which bends the lines of growth into so strong a curve as they cross the whorls. *Inner lip* is spread across the body as a thin glaze; it thickens a little toward the base of the pillar, round and behind which it spreads, so as to leave a minute umbilical pore. *Pillar* is very straight in the line of the axis, but is bent backwards more than is usual in the genus; its edge is narrow, rounded above, with a brilliant milky gauze, slightly reverted and sharp below, and ending in a fine point. H. 1·25. B. 0·4, least 0·38. Penultimate whorl, height 0·18. Mouth, height 0·28, breadth 0·22.

This resembles the *Turritella sinuata*, Reeve; but in that the apex is much finer, the earlier suture much shallower, and the whorls of much slower increase. It is extremely like some specimens in the British Museum, on a tablet numbered "906. Bass Strait," and on the back of which there is written "45 fms., coarse sand and dead shells;" but they are, I think, distinct. In many respects it recalls the well-known Mediterranean and Atlantic species *T. triplicata*, Broc.; but it is a smaller and more delicate species than that, and the finer spiral sculpture is very much more delicate and irregular.

2. TURRITELLA ACCISA, n. sp.

St. 162. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ E. S.E. Australia, off E. Moncœur Island, Bass Strait. 38–40 fms. Sand.

Shell.—Subulate, a very little contracted at the edge of the flattish and little conical base, with a strongly furrowed suture, on the lip a deep sharp sinus, thinnish, speckled. *Sculpture.* The surface is closely covered with very fine sharp scratches on the highly curved lines of growth, which are specially crisp on the base, where they are flexuous and unbroken. Spirals—there are on the last whorl two keels, one near (about 0·04 millim. from) the top, the other a little further (about 0·05 millim.) from the bottom of the whorl: both are blunt, roundly swollen bands defined by the sutural contraction, but the upper one is slightly the sharper; the under one is the stronger and better defined, the sutural contraction below it being more abrupt instead of presenting the mere sloping shoulder which lies between the upper band and the suture. Between these two carinations the slightly impressed surface is scored by several threads and furrows, of which sometimes one, sometimes two are stronger than the rest. Similar threads, but with feebler furrows, occupy the suprasutural contraction, the suture being marginated on its upperside by a small slightly swollen band; where the suture ceases at the upper corner of the mouth, this band forms the roundly angulated edge of the base, strongly defined by the furrow which lies above it. Besides these stronger spirals, the whole surface is irregularly scored with fine spiral threads. Towards the apex the minuter sculpture disappears, the two keels lose their prominence, and the whorls are sharply carinated by one of the

Labral sinus of *Turritella accisa*, W.

intermediate threads; the first two whorls are smooth. *Colour* a brownish yellow, with ruddy spots of undefined outline. These spots on the keels are large, on the intermediate threads they are small; they follow in their direction the curves of growth; the upper part of the spire and the middle of the base have a suffused stain of this colour. *Spire* is high, narrow, and perfectly conical. *Apex* very fine, ending in a minute, transparent, glassy knob, which is not in the least depressed or spread out. *Whorls* 15–16, of very gradual increase, almost flat on the sides, with a strong constriction below and a more gradual contraction above; the upper whorls are angulated. There is a slight contraction, and within that an angulation round the edge of the base, which is flattish and slightly conical. The first two are hyaline. *Suture* sharp and strongly defined. *Mouth* rather large, almost round. *Outer lip* scarcely advancing, sweeping freely out with a rounded curve from the body to the pillar, and rather patulous throughout, especially at the point of the pillar, where there is a slight canal. Between the two keels there is a deep V-shaped sinus, the form of which is preserved in the curves of growth. *Inner lip* is spread as a thin brown glaze, which just encompasses the base of the pillar. The *pillar* is narrow, rounded, with the lip-edge just turned back on it; it is curved and rather bent backward; the basal lip sweeps out beyond the point of it. H. 1·15. B. 0·34, least 0·31. Penultimate whorl, height 0·18. Mouth, height 0·21, breadth 0·17.

There are unnamed specimens of this species on a tablet in the British Museum numbered "924 *b*. Bass Strait, 40 fms." It is very like *Turritella pagoda*, Rve.; but that is a narrower shell, of slower increase, and with fewer spirals. *T. sinuata*, Rve.. is also slimmer and smoother, of slower increase, flatter whorls, and finer apex. *T. Gunnii* is very like, but is smoother, and has a still deeper and more impressed suture. In general aspect of form, colour, and sculpture it resembles *T. conspersa*, Ad. & Rve.; but the resemblance utterly disappears on closer observation. That is broader and squarer in the base, the colour is more blotchy and less suffused, the upper whorls of the spire are finer, the suture is much more impressed, and the whorls are much more angulated; it has no deep labial sinus, nor is any trace of that left on the lines of growth. The *T. incisa*, Tenison Woods, 45 fms., from Port Jackson, has the deep narrow sinus of this species, but seems to be a much smaller shell relatively to the

number of whorls, 11 millims. to 13 whorls being his measurement. *Turritella accisa* differs from *T. runcinata*, W., in being smaller, narrower, suture much deeper, upper whorls angulated and sculptured, not rounded, and smooth; and the apex is much finer and sharper, and is hyaline white, while in that species it is brownish yellow and hardly translucent.

3. TURRITELLA CARLOTTÆ, n. sp.

St. 162. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ E. Moncœur Island, Bass Strait. 38–40 fms. Sand.

St. 167 *a.* June 27, 1874. Lat. 41° 4′ S., long. 174° 19′ E. Queen Charlotte Sound, New Zealand. 10 fms. Mud.

Shell.—High, narrow, conical, with slightly impressed suture and an angular flattened base, thin, translucent, with fine ruddy spiral threads. *Sculpture.* Longitudinals—there are fine, thread-like, close-set curved lines of growth. Spirals—there are two principal, two secondary, and very many minor spirals; but the relative value of these varies a good deal; they are little raised, but distinct. The base is covered with fine crowded spirals, of which those near the edge are stronger than the rest. The microscopic system of spirals is fine, sharp, and distinct. *Colour* yellowish ashy white, with a suffused ruddy brown on the upper part of the whorls, and a stronger shade of the same colour defining the more important spirals. The colour becomes altogether paler up the spire, and the apex is white. *Spire* very perfectly conical; but the profile lines are interrupted by the impressed sutures. *Apex* small, rounded, smooth and glossy, consisting of 1½ embryonic whorl; the next whorl is slightly angulated, after which the regular sculpture begins. *Whorls* 15, very slightly convex on the sides, contracting gradually upwards into the suture; towards the bottom of the whorl the contraction into the suture is shorter, straighter (*i. e.* less convex), and more rapid; they are of very gradual and regular increase. Towards the upper part of the spire the curve of the profile line of each whorl becomes increasingly stronger. The base is flat, very slightly conical, sharply angulated, and not contracted at the edge. *Suture* very slight, but well defined. *Mouth* small, angularly rounded, a little higher than broad. *Outer lip* a little drawn in and advancing on the edge of the base, descends straight to the lower outer angle, is flat across the base, and a little patulous in front of the pillar-point. The generic sinus in the outer lip is parabolic in form. *Inner lip.* There is not (though the specimens are full-grown) even a

glaze across the body nor round the base of the pillar; but on older specimens this may probably exist. *Pillar* is a little concave, rather direct, with a thin rounded edge. *Epidermis* a very thin and delicate calcareous membrane, obviously not extraneous; it adheres to the top of the spirals and stretches across their furrows. It is sparsely cleft by minute gaping rents in the direction of the lines of growth, and the microscopic sculpture of the shell is traceable in it, but rather on its under than its upper surface. H. 0·95. B. 0·28, least 0·25. Penultimate whorl, height 0·15. Mouth, height 0·16, breadth 0·14.

This species has some resemblance, both in form and sculpture, to *T. knysnaensis*, Krauss, but it is narrower, suture less impressed, whorls not so convex; the embryonic apex is very like, but in the 'Challenger' species it is a little more swollen and depressed.

4. Turritella philippensis, n. sp.

St. 161. April 1, 1874. Lat. 38° 22′ 30″ S., long. 144° 36′ 30″ E. Off entrance to Port Philip, S. Australia. 38 fms. Sand.

Shell.—A narrow cone ending a little abruptly in a sharp point, profile lines straight, base angulated and flat, of a suffused brown colour with longitudinal brown flecks. *Sculpture.* Longitudinals —fine, numerous, close, much-curved lines of growth. Spirals— there is a slight angulated swelling at the top and bottom of each whorl (that at the top being rather nearer the suture than that at the bottom); between these the surface of the whorl is slightly concave, with a flat feebly projecting band in the middle, the upper and lower edge of which is defined by a spiral thread; besides these, which are absent in the upper whorls, the whole surface is marked by irregular and unequal narrow and almost obsolete spiral threads, which are stronger on the base. The generic microscopic spirals are strong, but without delicacy or depth. *Colour* ruddy light brown, with darker longitudinal curved flecks; on the upper whorls the centre of the whorl is coloured and the top and bottom is white; the three apical whorls are porcellanous white. *Spire* perfectly conical in its profile lines. *Apex*, the last whorl contracts suddenly and rises in a fine rounded, but almost sharp, point. *Whorls* 11; but the shell is not full-grown. They are almost flat on the sides, with a slight angular contraction into the suture above and below; the flat base is angulated at the edge and is a little conical. *Suture* is slightly impressed by a shallow broadish angular depression

Mouth, outer and inner lip, and *pillar* are not fully developed. The generic sinus is parabolic shaped. H. 0·61. B. 0·19, least 0·17. Penultimate whorl, height 0·12. Mouth, height 0·13, breadth 0·1.

This species is somewhat like *Turritella sinuata*, Rve., but is a narrower shell with higher whorls, which are less convex; the apical whorls are much larger, and the apex itself sharper and more prominent.

5. Turritella Cordismei, n. sp.

St. 162. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ E. Moncœur Island, Bass Strait. 38–40 fms. Mud.

Shell.—A very narrow cone ending in a small, slightly swollen, rounded, and depressed point, rather glossy, of a suffused yellowish-brown colour with ruddy spots. *Sculpture.* Longitudinals—there are many fine, close-set, deeply curved lines of growth. Spirals—on the edge of the base there are two strongish flattish threads, the lower a little contracted within the other; they are parted by a flat open furrow, in the bottom of which runs a fine thread: similar to this last there are about six equally parted spiral threads on the side of the whorls, and about seven, closer set, on the base; besides these there are several finer ones. The microscopic spirals of the genus are sharp and distinct. *Colour* a suffused yellowish brown, with small ruddy-brown and white flecks on the upper part of the whorls. The apex is glassy white. The whole shell is rather polished. *Spire* high and perfectly conical. *Apex* consists of 1½ small, rounded, slightly tumid and depressed whorl. *Whorls* 12 (but the shell is not full-grown); they are a little convex on the side, with a slight gradual rounded contraction into the suture above and below; but the convexity is less on the earlier whorls. The edge of the base is faintly contracted and bluntly angulated; the base is a little convex and but slightly conical. *Mouth &c.* not fully developed. The generic sinus on the outer lip is a deep semioval. H. 0·44. B. 0·13, least 0·12. Penultimate whorl, height 0·07. Mouth, height 0·1, breadth 0·08.

With some resemblance to *T. philippensis*, this species is much smaller, and differs entirely in sculpture and in the form of the whorls and shape of the apex.

6. Turritella austrina, n. sp.

St. 144 *b*. December 26, 1873. Lat 46° ?′ ?″ S., long. 37° ?′ ?″ E. Off Marion Island, Prince Edward Island. 100 fms.

St. 149 *d.* January 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Conical, with rounded whorls, basal angle, and base, a deeply impressed suture, a fine tapering point, a round mouth, two strong spiral threads on each whorl, a very distinct yellow epidermis. *Sculpture.* Longitudinals—there are many fine, faint, close-set, semicircular lines of growth preserving the curve of the labral sinus. Spirals—there are two strong rounded threads about one third of the whorl's height apart; they are nearly equally prominent and angulate the whorls, strongly in the earlier, less so in the later stages of growth. Between these is a shallow open furrow, in the middle of which is a fine narrow thread; one or two similar threads lie remotely on the upper slope of the whorl, where it contracts gradually into the suture; one spiral thread of the same kind lies in the open furrow, which abruptly contracts the bottom of the whorl into the suture. The edge of the base is contracted and rounded, with a strong spiral thread which meets the outer lip; the base is smooth but for the sharp and very strong generic spiral lines which cover the whole surface and are not microscopic, being easily seen with a lens. *Colour* porcellanous white under the straw-yellow epidermis. *Spire* high and conical; but its profile lines are deeply interrupted by the strongly contracted sutures. *Apex* drawn out to a fine, prominent, but rounded and slightly tumid point. *Whorls* 12, well rounded, with a slight double carination; the two carinating threads lie nearer the bottom of the whorl; they are separated by a shallow furrow: beneath the under one the whorl is sharply contracted into the suture, while from the upper keel the whorl slopes by a regular curve into the superior suture. The first 6 or 7 whorls are markedly smaller than those which follow. The base is round and rather prominent. *Suture* fine, but strongly marked by the contraction above and below. *Mouth* rather small, round. *Outer lip* slightly advancing on the edge of the base, somewhat open, very slightly angulated at the lower outer corner, a very little flattened on the base, patulous, and a little angulated at the point of the pillar. *Inner lip* crosses the body and coils round the base of the pillar as a very thin glaze. *Pillar* a little oblique, curved, patulous, sharp, and with a distinct twist on the edge. *Epidermis* very distinct, thin, membranaceous, and marked with the fine generic spiral lines; it is very caducous. In drying it seems to have risen through contraction, so as to remain attached

to the summit of the spirals, while it stretches across the intervening furrows. *Operculum* small, darkish brown, of very many flanged whorls. H. 0·8. B. 0·25, least 0·21. Penultimate whorl, height 0·12. Mouth, height 0·18, breadth 0·15.

This species is very like our British *Turritella terebra*, L., but is stumpier in form, smaller, with a much more impressed suture, and fewer spiral threads. Than *T. Hookeri*, Rve., Antarctic Expedition, this is also much stumpier, the apex is rounder and blunter, and the suture is deeper. Than *T. pagoda*, Rve., from which it also differs in form and suture, it is distinguished by a finer apex, and in that the second spiral thread is much weaker than in the 'Challenger' species. Than *T. knysnaensis*, Krauss, it differs in being stumpier, with a finer drawn and yet at last abrupter apex. It extremely resembles *T. duplicata*, L., but in form is stumpier, and the spiral threads are fewer. *T. triplicata*, Broc., has also more strong and very many more fine spirals.

7. Turritella deliciosa, n. sp.

St. 185*b*. August 31, 1874. Lat. 11° 38′ 15″ S., long. 143° 59′ 38″ E. Raine Island, Cape York, N. Australia. 155 fms. Sand and shells.

Shell.—Conical, with bicarinated contracted whorls and impressed suture, rounded base, blunt, rounded, and slightly tumid apex, porcellanous glossy white. *Sculpture*. Longitudinals—there are very many, irregular, close-set, fine, strongly curved lines of growth, which preserve the curve of the labial sinus. Spirals—each whorl is carinated by two strong, broad, rounded threads, of which the lower lies about one fourth of the height of the whorl above the inferior suture, while the upper is slightly nearer the superior suture. Close above each is a minute thread which is like the shadow of the others. Between the two keels the surface of the whorl is impressed by a broad, shallow, rounded furrow, in the bottom of which is a spiral thread intermediate in strength between the keels and their shadows. On the base there are about nine small spiral threads, the innermost of which are feebler than the rest; they are parted by slight shallow furrows which are narrower than the threads. The generic microscopic fretting can only be made out in peculiarly good light; but though very faint, it is certainly present in the furrows. *Colour* porcellanous, almost hyaline. *Spire* conical, drawn out, the profile lines just a little interrupted by the carinations of the whorls.

Apex small, consisting of two embryonic whorls, perfectly rounded, not depressed, slightly tumid, hyaline. *Whorls* 12, of very slow and regular growth, prominent at the keels, but contracted above and below and in the middle. The last is round and prominent on the base, in the centre of which it is impressed in an open umbilical pit. *Suture* very fine and inconspicuous; towards the end of the last whorl it is very deeply sunk, from the contraction of the outer lip upon the base. *Mouth* small, rectangularly triangular, the right angle being at the base of the pillar. *Outer lip* advancing a good deal at its junction with the base, and drawn in very much toward the base of the pillar, so that at this point its direction is very nearly at right angles to that of the shell's axis, curving a little, and retreating into the labral sinus; it here meets the nearly straight line of the patulous and prominent basal lip, which almost forms a sinus at the point of the pillar. *Inner lip* carried as a thin glaze across the body and round the base of the pillar, so as almost to form an umbilical chink behind it. *Pillar* perpendicular, straight, with a slight twisted swelling at about one third of its length; the edge is very thin and narrow, flat, patulous, and projecting at the side of the pillar as a small ledge. H. 0·35. B. 0·085, least 0·072. Penultimate whorl, height 0·038. Mouth, height 0·053, breadth 0·055.

This very beautiful little shell has some features which recall *Bittium*; but it has a distinct canal at the point of the pillar, and it has the labral sinus of *Turritella* as well as the peculiar microscopic spiral fretting of the genus, though this feature is very obsolete. It has, on the other hand, some features of strong individual peculiarity which separate it from any *Turritella* known to me. These are its pure hyaline porcellanous colour, its peculiar triangular-shaped mouth, and the *Vertagus*-like swelling on the pillar-lip, which, however, is not to be fonnd in the earlier stages of growth, as no trace of it appears in the many broken specimens. In general aspect it somewhat resembles *Cerithiopsis Jeffreysi*, E. Sm.; but that species is much more attenuated and ends in a sharp apex, has three strong spiral threads, and is longitudinally ribbed.

8. Turritella (Torcula) admirabilis, n. sp.

March 7, 1875. Admiralty Islands, N.E. of Papua. 16–25 fms.

Shell.—Conical, with a very slight convexity, angulated at the edge of the hollowed base, with a shallow impressed suture; whorls

a little rounded, slopingly shouldered above with a broad open labial sinus. *Sculpture.* There are very faint sharp curved lines of growth, strongest, as usual, on the base. Spirals—besides the bluntly angulated and slightly swollen basal carina, which appears as a slight projection above the suture at the base of each whorl, there are two threads whose prominence slightly carinates each whorl; they nearly trisect the whorl, but that the highest is a little more than a third of the whorl's height below the suture. There is another thread as broad, but less prominent, halfway between the lowest carinal thread and that above the suture; another, narrower, appears less than halfway between the upper carinal thread and the suture. On the upper whorls the upper carinal thread becomes much the most dominant and angulates the whorls. Besides these, the surface is closely covered with unequal, fine, flat-topped threads parted by very narrow square-cut furrows. There are of these threads about fifty above the basal carina of the last whorl. On the base there are about the same number, or rather more, of similar threads; but the furrows are opener and shallower. Of these basal threads some six or seven are rather stronger than the rest. They are all a little interrupted on the base by the radiating lines of growth. Besides these lines, the whole surface is exquisitely fretted with delicate close-set, microscopic spirals, of which about four go to $\frac{1}{1000}$ in., and much more coarsely scored with longitudinal bars (about one thousandth of an inch apart), which in the furrows of the larger system of spirals appear like the sharp edges of very thin lamellæ, and which are probably in some way connected with the epidermis of the shell. The whole of this microscopic system of sculpture is present on the base. *Colour* porcellanous white, irregularly stained with suffused streaky blotches of ruddy brown, which appears as minute sparse specks on the carinal threads and on the base. *Spire* is high, narrow, and slightly scalar. *Apex* is broken. *Whorls.* There have evidently been 16–17 (but the first two or three are gone), of very regular increase; a few near the apex are angulated in the middle, but all the others are concavely and slopingly shouldered below the suture, somewhat straight in the middle, and slightly contracted below, where they project a very little at the suture beyond the top of the succeeding whorl. The edge of the slightly concave and barely conical base is right-angled. *Suture* defined only by the small ledge which projects above it. *Mouth* square, bluntly pointed above, and rounded on

the outer lip. *Outer lip* advancing a little on the edge of the base, bending outwards and a little patulous to the upper carination, from which point it runs straight to the outer lower angle, flat across the base, patulous and slightly channelled towards the point of the pillar, which it runs beyond. The generic sinus is a mere open concave curve. *Inner lip* crosses the body more as a polish than a glaze. *Pillar* perpendicular, white, with a slight twist, narrow, and with a flattened and patulous rather than reverted edge. H. 1·55. B. 0·47, least 0·46. Penultimate whorl, height 0·23. Mouth, height 0·25, breadth 0·23.

This species is in form very like *T. conspersa*, Ad. & Rve., from the "China Seas;" but that has the lirations equal, the whorls are more angulated, and the angulation is not formed, as in *T. admirabilis*, by a thread, but by a swelling in the whorl itself. The sculpture extremely resembles *T. bicolor*, Ad. & Rve., "China Seas;" but that is in form very much more attenuated, has the suture much deeper, and the individual whorls are higher in proportion to their breadth.

9. TURRITELLA (TORCULA) LAMELLOSA, n. sp.

St. 162. April 2, 1874. Lat. 39° 10′ 30″ S., long. 146° 37′ E. Off E. Moncœur Island, Bass Strait. 38–40 fms. Sand.

Shell.—Like a *Terebra* in sharpness and slimness, perfectly conical, angulated at the edge of the base, which is flattish, with a strong, concavely curved, open, labial sinus, thin, translucent, and very pale-coloured. *Sculpture.* There are very many close-set, distinct, curved lines of growth, each of which is produced into a small, thin, sharp, appressed lamella. Spirals—above each suture the superior whorl projects in a slight rounded swelling, which slopes gradually outwards on its upperside, is slightly angulated at its greatest projection, and there defined by a fine thread, from which point it is suddenly, but not quite sharply, contracted into the suture. In some specimens this suprasutural swelling is very slight, being checked by a shallow open constriction which lies immediately above. The rest of the whorl is covered by a series of fine threads and shallow open furrows, 6 to 10 or 12 in number, varying much in strength and distance. Besides this larger system of sculpture, the whole surface (lamellæ and all) is fretted with the most delicate microscopic spiral ridges and furrows, which are faintly crimped longitudinally. The apical whorls are pretty sharply carinated and angulated about the middle, and are otherwise almost perfectly polished. *Colour* yellow ashy

white, with a few faint, suffused, small, ruddy blotches, chiefly on the spiral threads, but sometimes continuously curvedly longitudinal. The upper part of the spire is uniform white or ruddy. *Spire* high, narrow, and sharp, with straight profile lines. *Apex* glossy, porcellanous. The last 2½ whorls contract rather suddenly to the very small, sharply rounded, and prominent point. *Whorls* 16, perfectly flat, with a slight tendency to angular convexity in the earlier ones, of very regular and gradual increase; the last is bluntly angulated on the edge of the base, which is conical and slightly convex. *Suture* linear and very slightly impressed, defined by the slight swelling of the base of the superior whorl. *Mouth* small, square-shaped, but higher than broad. *Outer lip* advances somewhat where it springs from the base, and is here a little drawn in from the edge; it advances with a slight curve, and is a little patulous toward the outer lower corner, is flat across the base, and advances rather beyond the point of the pillar, where there is a slight open canal. The generic sinus of the outer lip is semicircular. *Inner lip*: a flat, but distinct, porcellanous white callus crosses the body-whorl and spreads, but with decreasing thickness, round the base of the pillar. The *pillar* is narrow, rounded, and perpendicular. H. 1·3. B. 0·3, least 0·29. Penultimate whorl, height 0·18. Mouth, height 0·19, breadth 0·16.

T. Gunnii, Rve., from "V. Diemens Land," has a much coarser spire, a deeper suture, and the angle of the base more rounded. In general aspect *T. declivis*, Ad. & Rve., is not unlike, but the 'Challenger' species is of more rapid increase, has not the same projection above the suture, and the whole details of sculpture are different; but the specimens of *T. declivis* in the British Museum from the "China Seas" are in very bad condition. It has some resemblance to *T. monilifera*, Ad. & Rve., "China Seas;" but is a thinner shell, not so fine toward the apex, and the upper whorls want the angulation of that species.

List of Polyzoa collected by Captain H. W. Feilden in the North-Polar Expedition; with Descriptions of new Species. By George Busk, F.R.S.

[Read June 15, 1880.]

(Plate XIII.)

Suborder I. CHEILOSTOMATA, *Busk.*

Fam. 1. Cellulariidæ, *Busk.*

Genus Scrupocellaria, *Van Ben.*

1 Scrupocellaria scabra, *Van Ben.* (sp.).

Cellurina scabra, *Van. Ben. Bull. Brux.* t. xv. p. 73, figs. 3–6.

Cellularia scabra (*forma* typica), *Smitt, Öfvers. Skand. Hafs-Bryozoer,* 1867, pp. 283 & 314, tab. xvii. figs. 27–34.

Cellularia scrupea, *Alder, Trans. Tynes. Field-Club,* vol. iii. p. 148.

Scrupocellaria scrupea, *Busk, Quart. Journ. M. Sc.* iii. p. 254 (non aliter).

Scrupocellaria Delilii, *Alder, ib.* n. ser. iv. p. 107, pl. iv. figs. 4, 8; ? *Busk, l. c.* vii. p. 65, pl. xxii. figs. 1–3.

Scrupocellaria scabra, *Norman, On Rare British Polyzoa, Q. J. Mic. Sc.* viii. p. 214; *Hincks, Polyzoa from Iceland and Labrador, Ann. N. Hist.* Jan. 1877, p. 98.

? Crisia Delilii, *Audouin, Savigny,* pl. xii. fig. 3.

Hab. Arctic Sea, August 11, 1875, 13–15 fms., stony bottom (*H. W. F.*); Sir Edward Belcher's Expedition!; Hamilton Inlet, Labrador (*Wallich*); Godhavn Harbour, Disco, 5–20 fms. (*Norman*); Sabine Island, German Polar Expedition (teste *Hincks*); Parry's Island, Spitzbergen, 6–150 fms. (*Smitt*): Britain (*Norman*); Northumberland coast (*Alder*): coast of Belgium (*Van Ben.*).

Upon further consideration of this species, I am inclined to believe with Prof. Smitt and Mr. Norman that the northern form, first accurately defined by M. Van Beneden, is not identical with that to which, from its resemblance to Savigny's figure, I gave the name of *Scrupocellaria Delilii*; this was collected by Mr. J. Y. Johnson at Madeira, and I have also seen a well-marked specimen from Suda Bay, Crete, for which I am indebted to Prof. W. K. Parker. In this latter more especially, the great size of the lateral avicularia and the upright position and large size of the vibracularium clearly indicate that it represents the species figured by Savigny, and these are precisely the characters noticed by Mr. Norman (*l. c.* p. 215) as distinctive of *S. Delilii* from

S. scabra. In other respects, however, the resemblance between the northern and southern forms is extremely close.

Genus Menipea, *Lamx.*

1. Menipea gracilis, mihi.

Char.—Zoœcia much elongated, subtubular downwards; aperture oval, border slightly thickened; usually a single spine on the outer side above and occasionally one on the inner; a broad arched, gibbous, entire operculum; anterior avicularium small, rare, and only (?) on the median zoœcium at a bifurcation. Median zoœcium not mucronate; five to nine cells in an internode. Polypide with 12 tentacles.

Cellularia ternata (*forma* gracilis), *Smitt, l. c.* 1867, pp. 283–310, pl. xvi. figs. 17, 18, 19, 20, 23, 24 (non 21, 22), (excl. syn.).

Hab. Franklin-Pierce Bay, 79° 29′ N. lat., 13–15 fms. (*H. W. F.*); Spitzbergen, 200 fms. (*Smitt*).

The differences between this form of *Menipea* and the well-known typical *M. ternata* appear to me to be so obvious that I am quite unable to agree with Professor Smitt in considering them merely in the light of varieties, *i. e.* if we are to understand that his "*forma*" is equivalent to "*variety.*"

The points to which I would advert as affording sufficient marks of distinction are:—

1. The greater number of zoœcia in each internode.
2. The marginal spines being limited at most to two unjointed ones.
3. The much greater expansion of the operculum.
4. The absence of a mucronate spine at the summit of the median cell at a bifurcation, whilst in *M. ternata* there is always an articulated spine or mucro in that situation and very often two.

Amongst the synonyms of his "forma *gracilis,*" Prof. Smitt gives my *Menipea arctica.* But upon again referring to the original type specimen of that species from Dr. Wallich's collection, procured in Hamilton's Inlet, Labrador, 15 fms., the differences appear to be quite as great as those which exist between *M. gracilis* and *M. ternata.* The general habit is altogether different, and in *M. arctica* there is not the vestige of an operculum; and the median cell is mucronate, the mucro, however, not being articulated as it usually is in *M. ternata.*

Fam. 2. BICELLARIIDÆ, *Busk.*

Genus BUGULA, *Oken.*

1. BUGULA MURRAYANA, *Johnst.* (sp.).

Flustra Murrayana, *Johnst., Sars, Danielssen, Packard.*
Flabellaria spiralis, *Gray, Brit. Radiata,* p. 106.
Bugula Murrayana, *Brit. M. Cat.* p. 46, pl. 59; *Smitt, l. c.* 1867, pp. 291 & 348, tab. xviii. figs. 19–27.
Avicella multispina, *Van. Ben.*

Hab. Franklin-Pierce Bay, 79° 29′ N. lat. (*H. W. F.*); Hunde or Hune Island, Davis Strait (*Dr. Sutherland*); Holsteinborg Harbour (*Norman*): Ireland (*Wallich*, teste *Hincks*); Orkney (*Lieut. Thomas*); Shetland (*E. Forbes*); Dublin coast (*W. McCalla*).

2. BUGULA FRUTICOSA, *Packard* (sp.). Pl. XIII. fig. 1.

? Cellularia quadridentata, *Lovén, MS.* 1834 (teste *Smitt*).
Bugula Murrayana (*forma* quadridentata), *Smitt, l. c.* pp. 292 & 351, tab. xviii. figs. 25–27.
Menipea fruticosa, *Packard, List of Labrador Animals,* p. 9, pl. i. fig. 3.
Bugula Murrayana, var. fruticosa, *Hincks, l. c.* p. 98; *Norman, 'Valorous' Dredgings.*

Without expressing any positive opinion as to whether Packard's form is to be regarded as specifically distinct from *B. Murrayana*, I am inclined to look upon it in that light*. The much slenderer habit—the branches being very often biserial —the usually total absence of marginal spines, or at most the presence of not more than one on either side above, the comparative rarity, and in many specimens the entire absence, of avicularia and their small size when existing, present to my mind a set of characters quite sufficient to justify the distinction of the more northern form from the typical *B. Murrayana*, which would appear but rarely to enter the Arctic zone, or at any rate to belong more properly to the temperate.

However this may be, the more abundant of the two *Bugulas* collected by Capt. Feilden agrees in all respects with Professor Smitt's figures 23 and 24; more especially as I have scarcely noticed any zoœcium with more than two very slender spines, though four are mentioned in Prof. Smitt's description.

* Since the above was in type I am more inclined to agree with those who regard *B. fruticosa* as a variety of *B. Murrayana*.

Fam. 3. Membraniporidæ.

Genus Membranipora, *Blainv.*

1. Membranipora unicornis, *Alder.*

Membranipora unicornis, *Alder, Cat. Zooph. North. & Durham,* p. 56, pl. viii. fig. 6.

Membranipora lineata (*forma* unicornis, ββ. stadium longius adultum), *Smitt, l. c.* pp. 365–399, pl. xx. figs. 30, 31.

? Reptoflustrella americana, *D'Orbig.*

Hab. Lat. 82° 27′ N. (*H. W. F.*) ; Hamilton's Inlet, Labrador, 15 fms. (*Wallich*!) ; Spitzbergen 6–50 fms. ; boreal and arctic seas generally (*Smitt*) ; coasts of Northumberland and Durham (*Alder*).

Fam. 4. Flustridæ.

Genus Flustra, *B. M. Cat.*

1. Flustra serrulata, n. sp. Pl. XIII. figs. 2, 3, 4.

Zoarium constituted of narrow, ligulate, bifurcated branches, slightly expanded at the ends; zoœcia ovoid or oblong, open in front, except quite at the bottom, where there is a very narrow calcareous expansion; border of aperture finely serrated or beaded; oœcia small, immersed.

Hab. Franklin-Pierce Bay, 13 fms. (*H. W. F.*).

This *Flustra* appears to be quite a distinct form. The growth is irregularly branched, the branches or lobes varying in width from one eighth to nearly one fourth of an inch, and they are usually forked and slightly expanded at the ends. The substance of the zoarium is thick, and as it shrinks much in drying it is necessary, in order to see the characters clearly, to expand it by boiling in water, unless the specimen has been preserved in alcohol. The peculiar finely serrulated or beaded border of the aperture is a very distinctive character.

Fam. 5. Escharidæ.

Genus Myriozoum, *Donati.*

1. Myriozoum coarctatum, *Sars* (sp.).

Cellepora coarctata, *Sars, Reise Lof. og Finm.* p. 28.

Leieschara (and Leiescharia) coarctata, *id. N. Norsk. Polyz.* p. 17.

Myriozoum coarctatum *et* subgracile, *Hincks, l. c.* p. 106; *Smitt, l. c.* pp. 18 & 119.

Millepora truncata, *Fabricius, Faun. Grœnl.* p. 432; *Packard, l. c.* (teste *Smitt*).

? Myriozoum subgracile, *D'Orb. Pal. Franç.* p. 662.

Millepora truncata (pars), *Lamouroux*; *Pallas.*

Hab. (Forma *subgracile*). Franklin-Pierce Bay, Smith's Sound, 13–15 fms. (*H. W. F.*); Arctic Sea (*Sir Ed. Belcher's Expedition!*); South Labrador (*Packard*); Newfoundland (*D'Orbig.*); Spitzbergen, 19–80 fms. (*Smitt*); Greenland (*Möller & Torell*); Holsteinborg Harbour, entrance of Baffin's Bay, 175 fms. (*Norman*, 'Valorous' Dredgings); Ireland, 100 fms. (*Wallich*, teste *Hincks*). (Forma *coarctata*) Norway (*Ström, Sars, &c.*); Finmark (*Lovén, Sars*).

That two apparently distinct forms of *Myriozoum* are found in the northern and Arctic seas admits of no doubt. The *Leieschara coarctata* of Sars, with a large avicularium above the mouth of almost every zoœcium, appears at first sight to be quite distinct from a slenderer form in which, as is often the case, there are no avicularia to be seen, or, in other cases, they are rarely and irregularly scattered amongst the mouths of the zoœcia, are of far smaller size, and arise, as it would seem, in the transformation of one of the pits or alveoli with which the surface of the zoarium is covered. Or, again, avicularia may be seen in the same situation as in the typical *M. coarctatum*, but of small size and very few in number. Upon the survey of numerous specimens from different localities, it seems to me that a transition can be traced between the typical form and that termed by Prof. Smitt *M. subgracile*, which, as he assumes, is in all probability identical with *M. subgracile* of D'Orbigny, from Newfoundland.

The few specimens, probably belonging to not more than one or two individual growths, collected by Captain Feilden are of the *subgracile* type, which would appear in all cases to be the more northern form.

It may be mentioned that there is a still slenderer, quite unarmed species in North Japan, in which the zoarium is not constricted, probably closely allied to the above.

Genus Eschara.

1. Eschara elegantula, *D'Orb.*

Eschara elegantula, *D'Orbigny* (1851), *Pal. Franç.* p. 102; *Smitt, l. c.*

1867, pp. 24 & 151, tab. xxvi. figs. 140–146; *Norman, 'Valorous' dredgings.*

Eschara saccata, *Busk, Ann. N. Hist.* ser. 2, vol. xviii. p. 33, pl. 1. fig. 1; *Sars, l. c.* 1862, p. 6.

Hab. Cape Napoleon, Cape Fraser, Aug. 11, 1875 (*H. W. F.*); Norway and Finmark (*M'Andrew*); Spitzbergen, Greenland, Finmark, 30–60 fms. (*Torell, Lovên, Sars*); Newfoundland (*D'Orbigny*); Hare Island, Waigat Straits, and lat. 66° 59′ N., long. 55° 27′ W., 57 fms. (*Norman*, 'Valorous' Dredgings).

As Professor Smitt states that he has compared specimens from the Arctic Seas with the type specimen in M. d'Orbigny's collection at Paris, there can be no doubt of the right to priority of D'Orbigny's designation. But I would remark that in none of the specimens of *E. elegantula* that have come under my notice have I observed the larger size of the lateral cells alluded to by the French naturalist as characteristic of the Newfoundland species.

The species is not mentioned by Mr. Hincks in his account of Dr. Wallich's collection from Iceland and Labrador; but I have several specimens received from Dr. Wallich, though from what precise locality is not recorded. The only indication placed upon them is "Arctic Sea, 100 fms."

2. Eschara perpusilla, n. sp. Pl. XIII. fig. 5.

Zoarium diminutive, constituted of irregularly forked branches. Stem and lower part of branches cylindrical, towards the ends flattened. Zoœcia fusiform, elongate; mouth looking directly upwards (horizontal); anterior lip tridentate, the median denticle wide and expanding, the lateral pointed, conical; immediately in front of the median denticle an avicularium about half the length of the zoœcium, with a circular mandible, which opens upwards and backwards.

Hab. Arctic Sea, Aug. 11, 1875, 13–15 fms.; Franklin-Pierce Bay, Smith's Sound (*H. W. F.*).

At first sight this form might be regarded as a very dwarf variety of *E. elegantula*, from the circumstance that in the mature condition the zoœcium has an avicularium in the same situation as the organ it occupies in that species. But further examination shows that the two forms are, in other respects, quite distinct.

The characters by which *E. perpusilla* may be recognized are:—

1. The far smaller size of the *zoarium*, which probably does not exceed an inch in height, and the cylindrical form, for the most part, of the stem and branches.

2. The smaller dimensions of the avicularium, and more especially of its mandible.

3. The tripartite dentition of the anterior or inferior lip.

4. The deep immersion of the mouth and of the orifice of the avicularium in the older stages of growth, these parts, in fact, in the stem and lower part of the branches being entirely overgrown and obliterated. But before the complete closure is effected, the mouth of the zoœcium, with the orifice of the avicularium and the median denticle immediately behind it, may be seen at the bottom of a deep pit, the mouth at this stage presenting a trefoil form, like the wound made by a leech-bite.

3. Eschara Sarsii, *Smitt* (sp.).

Escharoides Sarsii, *Smitt, l. c.* 1867, pp. 24 & 158, pl. xxvi. figs. 147–154.

Eschara rosacea, *Sars, N. Norsk. Polyz.* p. 3 (non *Busk*).

Cellepora cervicornis (var.), *Sars, Reise Lof. og Finm.* p. 28.

Hab. Franklin-Pierce Bay, Smith's Sound, 13 fms. (*H. W. F.*); Spitzbergen, 20–60 fms. (*Smitt*); Greenland (*Möller & Torell*); Finmark, 80–100 fms. (*Sars, &c.*); Arctic Sea (*Sir Ed. Belcher's Expedition*); in lat. 74° 0′ S., 172° 0′ E., 330 fms. (*Hooker*, Voyage of 'Erebus' and 'Terror').

In all the specimens I have examined in the present collection there is only a single avicularium on one side of the preoral sinus. The species is particularly interesting as being identical with one, of which I have specimens, collected by Sir J. Hooker, on the voyage of the 'Erebus' and 'Terror,' in the Antarctic seas, accompanied in the same collection by two other Arctic species.

Genus Hemeschara, *Busk.*

1. Hemeschara sincera, *Smitt* (sp.) (var. *inermis*).

Discopora sincera (*forma* Hemeschara), *Smitt, l. c.* 1867, pp. 28 & 177 pl. xxvii. figs. 178–180.

Lepralia (Discopora) sincera, *Hincks, l. c.* p. 102.

Hab. Franklin-Pierce Bay, Smith's Sound, 13 fms. (on *Cellepora cervicornis*) (*H. W. F.*); Spitzbergen, 19–60 fms. (*Smitt*); Finmark (*Lovén*); Arctic sea, —— ?, 100 fms. (*Wallich* !); Hare

Island, Waigat Strait, entrance of Baffin's Bay, 175 fms. (*Norman*).

A specimen from Spitzbergen, for which I am indebted to Professor Smitt, incrusts *Eschara elegantula*, and which is named by him "*Discopora sincera*," differs from Capt. Feilden's specimens and those collected by Dr. Wallich, and in fact from all others that have come under my observation, in the absence of any avicularium on the side of the cell, and in the larger and more uniform size of the zoœcia. Mr. Hincks's figure (*l. c.*) exactly represents Dr. Wallich's and Captain Feilden's specimens. This difference, however, considering the other identical characters, cannot be regarded as indicative of more than a variety.

2. HEMESCHARA LANDSBOROVII ?, *Johnst.* (sp.).

Lepralia Landsborovii, *Johnst.* (pars); ? *Brit. M. Cat.* p. 66, pl. 86. fig. 1.

Escharella Landsborovii (*forma* typica) (pars), *Smitt, l. c.* 1867, pp. 12 & 94, pl. xxiv. figs. 60–62 (*non cetera*).

Hab. Cape Fraser, 80 fms. (*H. W. F.*, on worm-tube); Spitzbergen (*Smitt*); Greenland, Copenhagen Museum (teste *Smitt*).

I follow Professor Smitt in terming this form *Landsborovii*, but am by no means satisfied that it should be referred to that species. There is no doubt, however, of the identity of Captain Feilden's specimens with the form figured as above cited by Professor Smitt. I should be more inclined to refer his *Escharella porifera* to that type.

Fam. 6. CELLEPORIDÆ.

Genus CELLEPORA, *Fabr.*

1. CELLEPORA CERVICORNIS, *mihi.* Pl. XIII. figs. 6, 7, 8.

Cellepora cervicornis, *Busk, Ann. N. Hist.* ser. 2, vol. xviii. p. 32, pl. 1. fig. 1.

Cellepora pumicosa, *Sars, Reise Lof. og Finm.*; *Danielssen* (teste *Smitt*).

Celleporaria incrassata, *Smitt, l. c.* 1867, pp. 33 & 198, pl. xviii. figs. 212–216; *D'Orbigny* (pars); non *Lamarck.*

Celleporaria surcularis, *Packard*, teste *Smitt.*

? Cellepora coronopus, *S. Wood, Crag Polyzoa*, p. 57, pl. ix. figs. 1–3.

Cellepora incrassata, *Hincks, l. c.* p. 105.

Hab. Cape Napoleon, Cape Fraser (*H. W. F.*); Norway and Finmark (*M'Andrew, Lovén, &c.*); Spitzbergen and Greenland

(very abundant), 16–160 fms. (clay and stone) (*Smitt*); Newfoundland (*D'Orbigny*); ? Crag (fossil) (*S. Wood*); in lat. 66° 59′ N., long. 55° 27′ W., 57 fms. (*Norman*).

Although there can be little doubt that this very abundant Arctic species is included in M. d'Orbigny's *Celleporaria incrassata*, I can see no reason whatever for considering that it has any thing in common with the Mediterranean form figured by Marsigli, which has an entirely different aspect, to judge from the wretched figure contained in his work, and which was taken by Lamarck as the type of his *C. incrassata.* I have therefore ventured to retain the appellation I gave this species in 1856, deeming it highly probable that it represented Mr. Couch's species, notwithstanding his statement that the branches are compressed, whilst they are invariably cylindrical and tapering in the Arctic form. Perhaps, however, in view of the multiple applications of the name *cervicornis* to species of *Eschara* and *Cellepora*, it would be better to use another term altogether.

The agreement in general aspect between this species and that of the Crag *Cellepora coronopus* of Mr. Searles Wood is very striking; but, upon comparison of the minute characters, I am not prepared positively to regard the two as identical.

Suborder II. CYCLOSTOMATA.

Fam. 1. Diastoporidæ, *Busk* (Brit. M. Cat. pt. iii. p. 27).

Genus Mesenteripora, *Blainv.*

1. Mesenteripora meandrina ?, *Searles Wood* (sp.).

Diastopora meandrina, *S. Wood, Ann. Nat. Hist.* (1844) xiii. p. 14.
Mesenteripora meandrina, *Busk, Crag Polyzoa*, p. 109, pl. xvii. fig. 2, pl. xviii. fig. 4, pl. xx. fig. 2; *Smitt, l. c.* 1866, pp. 398 & 432.
? Mesenteripora Eudesiana, *M.-Edw. Sur les Crisies &c.* pl. 14. fig. 1.
? Mesenteripora compressa, *D'Orb. l. c.* p. 756.
? Ditaxia compressa, *Hagenow, Bryoz. Maastr.* p. 50, pl. 4. fig. 10.

Hab. Franklin-Pierce Bay, Aug. 10, 1875, 15 fms. (*H. W. F.*); Greenland (*Torell*), 16–40 fms.; ? Coralline Crag (fossil) (*S. Wood*).

The resemblance between this species and the *Mesenteripora meandrina* of the Coralline Crag is so close as hardly to admit of doubt as to their identity. But in this regard I am disposed to place more importance upon the absence of anastomoses between the folds of the zoarium than Professor Smitt is willing to allow.

As the present collection affords only a single specimen of this very interesting form, and that of small size as compared with Crag specimens, it might fairly be allowed that the absence of anastomoses was accidental, and consequent upon youth; but when I find that the same character was presented in specimens examined by Professor Smitt, and which, according to his measurements, appear to have had about the same dimensions as the one collected by Capt. Feilden, I am much disposed to look upon it as a very important differential character. I regarded it as such in the case of the numerous fossil, mostly Cretaceous, forms of *Mesenteripora*, and should be equally inclined to regard it as distinctive between the existing Arctic species and that from the Coralline Crag. Among other points of difference I would mention:—

1. The greater thinness of the Crag species and the much greater size attained by the zoarium.

2. The apparently thicker peristome, and (so far as can be judged in fossil specimens that have been exposed perhaps to attrition) the circumstance that the extremities of the zoœcia were not produced beyond the surface, or much less so than in the recent form.

Genus Tubulipora.

1. Tubulipora ventricosa, *Busk*.

Tubulipora ventricosa, *Busk, Quart. Journ. Mic. Sc.* iii. p. 256, pl. ii. figs. 3 & 4; *Brit. Mus. Cat.* part iii. p. 26, pl. 32. fig. 4 (same figure).
Tubulipora (subgenus Proboscina) incrassata (var. , *forma* erecta), *Smitt, l. c.* 1866, p. 402, pl. v. fig. 4.

Hab. Arctic Sea, Aug. 11, 1875, 13–15 fms. (*H. W. F.*); Greenland (on fucus) (*Dr. Sutherland*).

I have omitted several synonyms given by Professor Smitt, not feeling that any certainty can be attached to them.

Captain Feilden's collection contains only a single specimen, but this affords excellent characters.

Suborder III. CTENOSTOMATA.

Fam. 1. Vesiculariidæ.

Genus Farrella, *Ehrenb.*

1. Farrella ——?, n. sp. Pl. XIII. fig. 9.

Zoœcia in opposite pairs at very distant intervals on a slender tubular stem. The largest 0''·06 × 0''·013.

The only Ctenostomatous species is represented by one or two imperfect specimens parasitic upon *Bugula fruticosa*. These, moreover, are so few and so much injured and overgrown by Diatoms, that it is impossible to give an accurate definition of the form, which does not appear to resemble any British species with which I am acquainted, nor does it correspond with Leidy's description and figure of *Bowerbankia gracilis*. In case it be new, it might be termed *Farrella*, or, if with a gizzard, perhaps *Bowerbankia arctica*.

DESCRIPTION OF PLATE XIII.

Fig. 1. *Bugula fruticosa*, Packard. Portion, enlarged 25 diam.
2. *Flustra serrulata*, n. sp. Forked branch, of nat. size.
3. " " Another small piece, of natural size.
4. " " A portion, magnified 25 diam.
5. *Eschara perpusilla*, n. sp. A forked branch, magnified 25 diam.
6. *Cellepora cervicornis*, Busk. Bifurcating branched portion, of natural dimensions.
7. A zoœcium of *C. cervicornis*, enlarged 50 diam.
8. Zoœcium of same, also magnified 50 diam.
9. *Farrella arctica*, n. sp. Portion, enlarged 25 diam.

On the Classification of Gasteropoda.—Part II. By John Denis Macdonald, M.D., F.R.S., Inspector Gen. R.N. (Communicated by G. E. Dobson, M.B., F.L.S.)

[Read November 18, 1880.]

The Scutibranchiata, which were in my former system* incorrectly associated with the diœcious Gasteropoda, have been arranged in the above revised Table with the other Gasteropoda Monœcia.

The conscientious naturalist, like the theologian, is always in quest of the truth; and consequently, if he finds that this has been arrived at by one or many workers, it need not be subverted for the pure sake of change, or of presenting a subject in a more novel garb. I have therefore adopted the very natural and simple distribution of the Scutibranchiata given by Dr. Gray in his 'Guide to Mollusca,' carrying out an alteration which he has himself suggested, and the propriety of which has indepen-

* See 'Transactions of the Linnean Society,' vol. xxiii. p. 69 (1860).

dently occurred to me when studying the Helicinidæ, and comparing them with the true Nerites, both aquatic and marine. I would merely further take the liberty of inverting the order in which Dr. Gray's families are arranged, as being thus disposed more in accordance with the method adopted in classifying other natural groups in the first part of this paper. This will be permitted, I am sure, even by the most conservative, as by doing so no natural affinities will be violated, while we shall have the satisfaction of seeing that *Helicina* and its congeners are not thrown more widely apart from the other so-called Pulmonifera operculata than can possibly be helped. Raphidoglossa (or needle-beset tongue, as the word implies) is scarcely descriptive enough, or even suggestive of the complex and beautiful structure which it is intended to express; but inasmuch as we have been now sufficiently accustomed to associate the name with the thing signified, it would be unnecessary to alter it. The term Heteroglossa may also be retained as indicative of what may be clearly recognized to be a morphological modification of the primary type (Raphidoglossa).

Dr. Gray saw the necessity of arranging *Proserpina* and *Ceres* with the Scutibranchiata, their dentition being *raphidoglossal*, though it was only possible for him then to append them to what had been already printed. He prepared the suborder Pseudobranchia for their reception. This was a step in the right direction; and doubtless if he had not been misled by some means so as to have supposed the dentition of *Helicina* to be *septiserial* instead of *raphidoglossal*, which it truly is, he would have placed it in the same category with *Proserpina* and *Ceres*. There would thus be good reason for removing both the Olygyradæ* and Proserpinidæ from their association with the Cyclophoridæ and Littorinidæ.

If we now take the two orders Heteroglossa and Raphidoglossa, and apply the test of analogy as suggested in the first part of this paper, we shall find a rather interesting result. Thus *Cryptochiton* in the former group would nearly represent the *shelless Deridobranchus* in the latter; *Patella* would be answer-

* *Olygyra*, Say, is merely a synonym of *Helicina*, upon which Dr. Gray has founded the family name Olygyradæ, though the generic name of *Helicina* is retained to the exclusion of *Olygyra*. In a somewhat similar way the family name *Olividæ* is preserved, while the generic name *Strephona* is made to supersede that of *Oliva*.

able to *Scutus* or *Parmophorus*, and *Dentalium* to *Fissurella*; while the further progress of shell-development is to be traced through *Teinotis*, *Haliotis*, *Scissurella*, *Trochus*, *Turbo*, *Nerita*, and *Neritina*, winding up with the pulmoniferous genera *Helicina*, *Proserpina*, and *Ceres*.

If all the genera given by Dr. Gray with *Helicina* as Olygyradæ really exhibit the *raphidoglossal* type of dentition, this group will become of more importance than has hitherto been supposed.

Classification of the Gasteropoda (continued).

Division II. DIŒCIA (sexes distinct).

Subdivision I. *Lingual membrane unarmed, or with pleural teeth only.*

Order I. Proboscis lengthy and completely retractile, or shorter and not completely retractile in the aberrant family of *Ianthinidæ*.

(*a*) Both rachis and pleuræ unarmed		....	*Pyramidellidæ* and *Cancellariidæ*.
(*b*) Pleuræ represented by a single series of teeth on each side	curved*, simple	...	*Pleurotomidæ*.
	straight,	simple ...	*Acusidæ*.
		barbed ...	*Conidæ*.
(*c*) Dentition in the form of a double pavement.	Outer teeth with additional cusps	....	*Solariidæ*†.
	All the teeth simple and uncinate	....	*Scalariidæ*. *Ianthinidæ*.

Subdivision II. *Lingual membrane strap- or ribbon-like.*

Order I. Proboscidifera. Proboscis lengthy, retractile; ear-sacs with otoliths.

Suborder 1. Orthodonta. Dental processes in general pointing directly backwards from or from near the posterior border of the basal plates.

a Lingual dentition uniserial (rachidian)				....	*Volutidæ*.
b Lingual ntition iserial.	Rachis and pleuræ comb-like.	Dental processes numerous, small.	Strap short	....	*Mitridæ*.
			Strap long	teeth short......	*Fasciolariidæ*.
				teeth long	*Fusidæ*.
		Dental processes few and large		....	*Turbinellidæ*.
	Pleuræ uncinate.	Uncinus with an additional internal cusp		......	*Buccinidæ*.
		Uncinus simple. Rachis armed.	Cusps large and few	....	*Muricidæ*. *Olividæ*. *Harpadæ*.
			Cusps small and numerous.		*Turritidæ*.
		Uncinus foliated.	Rachis unarmed	....	*Columbellidæ*.

* For figures of the different forms of dentition here referred to, see my paper "On the Homologies of the Dental Plates and Teeth of Proboscidiferous Gasteropoda," in Ann. and Mag. Nat. Hist. 1869, iii. pp. 113-116, pl. xiii.

† The ear-sacs in this family alone have otoconia; all the others have single spherical otoliths.

Suborder 2. Anaclodonta. Cusps recurved from the fore part of the basal plates. Dentition typically septiserial, but in some instances reduced to 5 or 3 rows by suppression,

Velutinidæ.		*Ranellidæ.*
Naticidæ.		*Doliidæ.*
Tritonidæ		*Cassididæ.*
	Strombidæ.	

Order II. Rostrifera. Muzzle simple or proboscis rudimentary.

Suborder 1. Orthodonta. Cusps direct.

Pelagic. *Heteropoda.*
Marine. *Phoridæ.*

Suborder 2. Anaclodonta. Cusps recurved.

Marine and littoral...	*Cypræidæ.*	
	Vermetidæ.	
	Calyptræidæ.	
	Planacidæ.	
	Littorinidæ.	
	Rissoidæ.	
	Truncatellidæ.	*Cerithiidæ.*
Aquatic..................	*Melaniadæ.*	*Cerithidea.*
	Paludinidæ.	*Potamidinæ.*
	Valvatidæ.	
Terrestrial	*Cyclostomidæ* and their allies.	*Cyclophoridæ.* *Diplommatinidæ.*

All the families in the first column have *otoliths* in their ear-sacs; the few on the right have *otoconia.* This may be significant; but the subject requires further study.

Just as we have found terrestrial, aquatic, and marine Nerites, there is good promise that corresponding groups may be discovered in relation to other types of Anaclodontous Rostrifera with septiserial ribbons, the grouping of which is at present very imperfect. In this research, however, the shell-characters must be subsidiary to the most critical record of the anatomy of well-determined species, so as to afford legitimate grounds for their adoption or rejection as the case may require.

Indeed, from my own experience, I am quite sure that without this test the assumption of the alliance of even one so-called species with another founded on superficial resemblances can only be guesswork, allowable certainly for convenience and provisional arrangement, but it must always be amenable to the dictum of more precise anatomical knowledge.

MOLLUSCA OF H.M.S. 'CHALLENGER' EXPEDITION.—Part VII.

By the Rev. ROBERT BOOG WATSON, B.A., F.R.S.E., F.L.S., &c.

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[Read December 2, 1880.]

Families and Genera.

PYRAMIDELLIDÆ, viz. *Aclis, Fenella, Dunkeria?*
NATICIDÆ, viz. *Natica.*
CASSIDEA, viz. *Oniscia.*
TRITONIDÆ, viz. *Triton, Ranella, Nassaria.*

ACLIS, *Lovén.*

1. *Aclis mizon*, n. sp.
2. *Aclis hyalina*, n. sp.
3. *Aclis sarissa*, n. sp.

1. ACLIS MIZON, n. sp. (*μείζων*, rather large.)

St. VII. P. Feb. 10, 1873. Lat. 28° 35′ N., long. 16° 5′ W. Teneriffe. 78 fms. Coral.

Shell.—Broadly subulate, high, conical, umbilicated, thin, glassy, feebly ribbed longitudinally. *Sculpture.* Longitudinals—on the penultimate whorl there are about 40 feeble unequal rounded riblets, which run obliquely from left to right across the whorl; they die out on the last whorl, which, towards the mouth, presents a slightly malleated surface; on the upper whorls these riblets are fewer but more equal and distinct, but gradually die out towards the apex; they are parted by furrows rather broader than themselves; on the base they are very feebly present; the whole surface is further covered with faint irregular hair-like lines of growth. Spirals—there are a few very feeble, flatly-rounded, barely raised threads on the last whorl; these are rather more distinct on the base. The edge of the base is slightly and hesitatingly angulated; the lip of the umbilicus is much more distinctly and sharply so. *Colour* thin transparent white, so as to be almost glassy. *Spire* conical, long and fine. *Apex* small, quite regular, and perfectly rounded, with a minute flattening down of the extreme point of the first whorl, merely sufficient to prevent its being prominent. *Whorls* 15–16, of very gradual and regular increase, rounded, but the equal curve is slightly flattened for the first two fifths of the whorl's height; the base is flatly rounded and rather produced. *Suture* linear, regular, impressed.

Mouth rather small, rhomboidal, having an acute angle above and at the point of the pillar, and an obtuse angle at the corner of the base and at the top of the pillar. *Outer lip* very thin and sharp; it joins the body just at the circumbasal angulation, and springs at once very much forward, so as to form with the body a small, shallow, but acute-angled sinus; with a slight and regular forward curve it thus advances to the angulation of the base, from which it runs straight, flat, and slightly patulous to the point of the pillar, which it joins at a bluntly-acute angle, forming a slight but not at all incised canal. *Pillar* is not at all oblique, but is very slightly concave. *Inner lip* is entirely discontinuous across the body, and first makes its appearance in a small and slight porcellanous pad, which closely encircles the base of the pillar; its sharp-edged, narrow, and slightly patulous face forms the entire pillar. *Umbilicus* lies behind the thin pillar-lip, and is a distinct, little, pervious, funnel-shaped pore, sharply defined by the intrabasal carination. H. 0·62. B. 0·2. Penultimate whorl, height 0·083. Mouth, height 0·12, breadth 0·088.

I doubt very much whether this species really belongs to this genus. From Sars's *Hemiaclis* it seems, judging from his diagnosis and excellent drawings, to be distinguished by the thinness of the spire and by the minuteness of the apex, the size of the umbilicus, and the smallness of the mouth; in doubt, therefore, I accept Dr. Gwyn Jeffreys's advice, and classify it as an *Aclis*, a convenient, because somewhat vague group. I have said that the shell is broadly subulate. The measurements show very plainly that it is so only relatively to its fellows in the genus.

2. Aclis hyalina, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Broadly subulate, high, conical, umbilicate, ribless or *very* faintly ribbed on the earlier whorls, thin, glassy. *Sculpture.* Longitudinals—there are very many, close-set, faint, irregular angulations of the surface, which, besides, is covered with very fine hair-like striæ; these under a lens look very sharp and regular, but under the microscope are seen to be rounded and irregular, made up of little inconstant curves, with changing swellings and depressions. Spirals—the surface is faintly malleated in a somewhat orderly fashion; but besides the larger system of malleations there is a second system a good deal smaller and more irregular,

and the raised edges of these very slight depressions run in very numerous irregular and variable spiral lines, which are so slight as only to be visible in a changing light. On the base the longitudinal striæ are rather stronger, and the spiral system feebler than on the spire. The edge of the base is rounded, but there is a change of course at that part which produces a very slight angulation. The lip of the small umbilicus is thickened and angulated. *Colour* glossy on the surface; the shell is milkily transparent, glassy, and thin. *Spire* conical, with a very slightly concave profile, long and fine. *Apex* small, rounded, but with a very slight contraction and prominence on one side, in consequence of the extreme tip being not entirely suppressed. *Whorls* 12, of gradual and regular increase, convex; the base is rounded, slightly tumid, and produced. *Suture* linear, regular, rather sharply though minutely impressed. *Mouth* small, oval. *Outer lip* leaves the body a little below the contraction of the base; from this point it advances forwards so as to form with the body a small but acute-angled sinus; it sweeps round, not patulous, with a very regular curve to the point of the pillar, which it joins at a bluntly-acute angle, and forms there a slight but not at all incised canal. *Pillar* is very slightly oblique and a little concave. *Inner lip* is entirely discontinuous across the body, and first appears in a minute thin abrupt edge, which surrounds the base of the pillar; its very thin, narrow, and slightly patulous face forms the entire pillar. *Umbilicus* lies behind the thin pillar-lip, and is a minute deep funnel-shaped pore, sharply defined by its angulated and thickened basal lip. H. 0·42. B. 0·15. Penultimate whorl, height 0·062. Mouth, height 0·094, breadth 0·064.

This species is very closely related to *A. mizon*, W., and in any classification they will certainly go together. From that species this differs not only in the ribs, which are probably a very variable feature, but, besides, the shell is proportionally broader, the spire is less attenuated, the base is rounder and more tumid, the suture is more *linearly* impressed and less open, the whorls are more regularly rounded and of more rapid increase, the apex is larger, and the extreme tip is more projecting.

3. Aclis sarissa, n. sp. (*sarissa*, a pike.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Subulate, conical, smooth, white, glossy, with rounded

whorls and a somewhat impressed suture. *Sculpture.* Longitudinals—there are a few very minute and faint lines of growth. Spirals—there are a few irregular and very slight transverse angulations, which are connected with a very subdued and almost invisible malleated surface, which may be seen in a changing light. *Colour* white, probably transparent in fresh specimens; the surface, which is glassy, is very smooth. *Spire* conical, but not quite regularly so, being slightly convex in the middle and very faintly concave above and below. *Apex*, for the genus and relatively to size, blunt, almost slightly tumid, round, but with the faintest conceivable prominence on one side of the extreme tip. *Whorls* 9, of regular increase, though the last is a little disproportionally large, well rounded; the last, which is slightly tumid, has a very faint trace of angulation below the suture and at the edge of the base, which is flatly rounded and projecting, with a slightly thickened and angulated carination round the umbilicus. *Suture* linear, impressed, and very slightly oblique. *Mouth* oval, bluntly angulated above, effuse on the base and slightly so on the outer lip. *Outer lip* is slightly pinched in at its union with the body; from this point it runs out to the right with a free curve, but, speedily turning to the left, its course is straight, and here it is prominent, and it becomes increasingly patulous as it curves quickly round to join the pillar. *Pillar* is not at all oblique, but is slightly concave. *Inner lip* crosses the body on a thin but sharply-edged pad; it is thin, sharp, and scarcely patulous on the front of the pillar. *Umbilicus*: there is a small funnel-shaped trough between the pillar-lip and the angulated edge of the base, but this contracts immediately to a mere chink. H. 0·153. B. 0·053. Penultimate whorl, height 0·026. Mouth, height 0·039, breadth 0·03.

This species is like *A. Walleri*, Jeffr., but certainly distinct; the shell is broader, the whorls, which are fewer (9 instead of 11), are rounder, being less flattened, constricted above and less bulgy below, the spire, which is less regularly conical, is not so attenuated, the apex is not nearly so fine, and the surface of the shell is smoother, the longitudinals being less visible, while the malleated structure, which also exists in *A. Walleri*, is here even less visible.

FENELLA, *A. Ad.*

I have put this genus here rather for convenience than from

having any definite view of its true place. Mr. Adams considers it most nearly connected with *Rissoa* (subgen. *Alvania*); but his description of the animal does not justify this estimate; and, so far as I am aware, its true place is undetermined.

FENELLA ELONGATA, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Culebra Island, St. Thomas, West Indies. 390 fms. Coral-mud.

St. 78. July 10, 1873. Lat. 37° 24′ N., long. 25° 13′ W. Off San Miguel, Azores. 1000 fms. *Globigerina*-ooze.

Shell.—Small, high, narrow, conical, with deep wide sutures and rounded whorls and base, translucent white. *Sculpture.* Longitudinals—on the last whorl there are 12–13 narrow and sharply-rounded, but not high, ribs, parted by furrows about four times their width; they cross the whorls with a slight sinistral obliquity, and are abruptly interrupted on the last whorl by the edge of a basal tabulation, where the entire base is levelled up beyond the summit of the ribs, which thus all but disappear. On the earlier whorls the ribs are rather fewer in number, and are somewhat closer set; on the third they are crowded, on the second and first they are absent. There are besides these very numerous, close-set, rounded, microscopic threads on the lines of growth; these, as usual, are most distinct on the base. Spirals—there are on each whorl three very narrow rather prominent threads, which rise into tubercles in crossing the longitudinal ribs. The highest, which is the strongest, is about two fifths of the whorl's height below the suture, the costal tubercles on it are sharp and prominent, and it forms a distinct though not strong carina; on the last whorl the edge of the basal tabulation, which exactly meets the outer lip, forms a fourth thread, and between all the spirals there is a faint trace of one intermediate, like a shadow; on the tabulation of the base there are three or four very feeble and faint rounded threads. *Colour* glossy, transparent white. *Spire* very high and narrow, perfectly conical, but having its outlines broken by the strong sutural contractions which constrict the top and bottom of each whorl. *Apex* small and regularly attenuated, but blunt and quite round, the extreme end being slightly impressed. *Whorls* 12½, of very gradual and regular increase, with a sloping shoulder below the suture, roundly bulging and slightly contracted into the suture below: the projection of the

spiral threads gives the curve of the whorls a slight angulation, which is strongest at the carinal or highest of the three threads; the base is rounded and scarcely at all projecting. *Suture* lies in the bottom of a deep and broad angular constriction, and is well marked above by a minute round thread. *Mouth* small, gibbously oval, slightly pointed above and in front of the pillar. *Outer lip* thin, advancing very little at its junction with the body, and there a little contracted, slightly patulous in all the rest of its sweep. *Pillar* very perpendicular, concave and narrow. *Inner lip* is carried across the body as a thin glaze; it spreads out a very little just at the base of the pillar, up which it advances with a very narrow and slightly angulated, but not at all reverted edge. H. 0·36. B. 0·1. Penultimate whorl, height 0·05. Mouth, height 0·05, breadth 0·048.

This is a little shell of remarkable beauty. Its generic place has been very difficult to determine. Its outer lip is a little chipped, which has added to the difficulty. There are none of the microscopic spirals which characterize *Turritella*. There is no such siphonal canal as would justify its being classed as a *Cerithium*. The longitudinal sculpture separates it from *Mesalia*. Mr. Edgar Smith recommended *Fenella*, where it is now placed, because nothing more satisfactory suggests itself. Mr. A. Adams's diagnosis of the genus * " . . . labro simplici, acuto, non reflexo, incrassato aut varicoso," implies that the outer lip is not reflected, but is *either* thickened *or* varicose. In none of the species described is this feature mentioned; and Mr. E. Smith assures me that among the *Fenellas* of the British Museum, "of which we have several species and many specimens, I do not find any thickening or varix on the labrum." It seems probable, therefore, that Mr. Adams's thought was "non reflexo, incrassato nec varicoso," and that "aut" slipped in by accident and transformed his meaning. Still, a slight difficulty remains, since the aperture is not quite "*integra antice*," as the old lines of growth indicate, in spite of the chipped lip; but the indication of an "emargination" is too slight, as is said above, to allow the shell being placed under *Cerithium*.

DUNKERIA, *Carp.*

DUNKERIA FALCIFERA, n. sp.

St. 56. May 29, 1873. Lat. 32° 8′ 45″ N., long. 64° 59′ 35″ W.

* Ann. & Mag. Nat. Hist. 1864, xiii. p. 40; Journ. de Conch. 1868, p. 47, pl. iv. fig. 5.

Bermudas. Bottom temperature 38°·2. 1000–1075 fms. Grey ooze.

Shell.—Small, high, conical, tapering a little abruptly to a fine point, with rounded whorls and base, longitudinally and spirally ribbed. *Sculpture.* Longitudinals—in the last two whorls there are 14–15 rather narrow and sharpish ribs; they slowly increase in number as one follows them up the spire; on the two subembryonic whorls they suddenly increase to about 30. At the top of each whorl they are small, sharp, and strongly convex towards the left; lower down on the whorl they are straight; they are parted by flattish furrows two to three times their breadth; on the last whorl they are oblique and somewhat irregular in form and arrangement, on the base they disappear. Besides these the whole surface of ribs and furrows is scored with microscopic rounded and very distinct threads. Spirals—on each whorl there are five small rounded spiral threads; the highest and strongest lies at about two fifths of the whorl's breadth below the suture, and forms an angular shoulder on the whorl, whose chief projection is at this point; the rest are pretty equally distributed on the whorl; the fourth is weaker than the two above it, and the fifth, which is still smaller, lies exactly at the suture. All of these, but especially the first, rise into little sharpish knots as they cross the ribs; on the subembryonic whorls they disappear. *Colour* glossy, translucent white. *Spire* high and conical, but the upper fourth of the shell tapers a little abruptly to a very fine point; its outlines are broken by the strong sutural constriction. *Apex*: the extreme tip is broken. *Whorls*: there are eight below the missing embryonic one, of rapid growth in height and breadth; they have a sloping shoulder below the suture down to their point of chief breadth at the carination; from this to the third spiral, where is also a slight carination, they have a straightish outline; below this they contract on an equable curve into the suture; the base is roundly conical. *Suture*: its place is strongly defined by the constriction at the top and bottom of each whorl and by the lowest spiral, which forms its upper edge, but it is much interrupted and obscured by the curved points of the ribs, which bend round convergingly into it. *Mouth* gibbously oval, being almost semicircular to the right and obliquely straight on the body and pillar. *Outer lip* thin, advancing strongly at its junction with the body, from which point it retreats with a rapid open curve, which produces the sickle-like

form of the ribs from which the species is named; across the base it is slightly flattened and patulous, with a faint open canaliculation towards the point of the pillar. *Pillar*, with a minute but distinct twist, is very oblique both backwards and to the left; the line of it runs very straight across the body and out nearly to the point of the pillar, where it curves round to join the basal lip. *Inner lip*: a thinnish porcellanous glaze crosses the body and spreads a little outside of the mouth and round the base of the pillar, to which it also forms a very narrow, thin, and flatly patulous edge, which is angulated both to the inside and the out. H. 0·26. B. 0·09. Penultimate whorl, height 0·044. Mouth, height 0·055, breadth 0·05.

This very beautiful little shell has some features of resemblance to the last (*Fenella elongata*, W.). The twist on the pillar-lip, though very slight, is unmistakable; and this feature makes the absence of the extreme tip of the apex the more to be regretted, as its character would have determined whether this species ought not more properly to have been classed among the *Odostomias*. *Dunkeria*, however, has an elasticity which makes it very suitable for a doubtful classification. Dr. Philip Carpenter, in the Mazatlan Catalogue, p. 433, in establishing the subgenus, says that it "combines the characters of *Chemnitzia* and *Aclis*, presenting the mouth of the former with the rounded whorls of the latter. It agrees with all the other sections of the family in having its limits badly defined."

NATICA, *Adanson*.

1. *N. philippinensis*, n. sp.
2. *N. atypha*, n. sp.
3. *N. pseustes*, n. sp.
4. *N. suturalis*, n. sp.
5. *N. radiata*, n. sp.
6. *N. amphiala*, n. sp.
7. *N. leptalea*, n. sp.
8. *N. xantha*, n. sp.
9. *N. prasina*, n. sp.
10. *N. fartilis*, n. sp.
11. *N. apora*, n. sp.

1. NATICA PHILIPPINENSIS, n. sp.

St. 210. Jan. 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E. Philippines. 375 fms. Mud. Bottom temperature 54°·1.

Shell.—Rather depressedly but conically globose, umbilicate, with rounded prominent whorls, thickish, slightly ribbed and spirally striate, yellowish, with a brownish band above the periphery. *Sculpture.* Longitudinals—the upper whorls are closely

crossed by numerous riblets, whose front edge is sharp; they are strongly convex in front, especially near the top of the whorl; on the last whorl these become feeble, especially at the periphery; besides these there are slight, close-set, rounded striæ on the lines of growth. Spirals—the whole surface is scored by faint irregular and unequal furrows and microscopic lines; there is a twisted, prominent, but blunt umbilical carina. *Colour* porcellanous white under the yellow epidermis, with a broad buff band which extends from the periphery halfway to the suture. *Epidermis* yellow, thin, glossy, but roughened by longitudinal folds. *Spire* short, but raised. *Apex* very small, prominent, but the extreme tip scarcely rises into view. *Whorls* 6 (of which the first three are embryonic and of a faint brownish purple), tumid, well rounded, of rapid increase. *Suture* nearly horizontal, deep, almost channelled. *Mouth* not much oblique, a little gibbously semicircular, slightly more than three fourths of the whole height of the shell, open, slightly and bluntly angulated at the point of the pillar, pure white within, but with a slight ruddy tinge, deepening to a rusty stain towards the edge of the lip, where the buff spiral band lies. *Outer lip* a little contracted above, and there faintly flattened; it curves very equably throughout its whole sweep; it is open, but with a straight sharp edge, and projects bluntly at the extreme point of the shell, where the umbilical carina joins it. *Inner lip* pure white, straight, oblique, flat, and obsoletely channelled within, with a slightly thickened rounded edge; it is joined above to the outer lip by an expanded but not very large nor thick callus; below this, where it leaves the body-whorl, it is thin and hollowed out, but below the middle of the umbilicus it is thickened by a prominent umbilical callus; below this it is slightly more reverted and thicker than above, and it is very obtusely angulated towards the point of the pillar. *Umbilicus*, which is defined by the basal carination, is deep; in consequence of the thinning and hollowing out in the inner lip above and of a strong furrow between the umbilical callus and the basal carina, it looks as if it were large, but it is contracted by the low-lying and strongish spiral callus within. H. 0·67. B. 0·6. Penultimate whorl, height 0·16. Mouth, height 0·505, breadth 0·407.

This species is very like the young of *N. rufa*, Born, from Singapore; but it is higher in the spire; the umbilical pad, which is white, not brown as in that other, is also smaller, lower in position, and

separated distinctly from the pad at the upper angle of the mouth; the radiating wrinkles on the upper whorls are much stronger and more regular, and the embryonic apex is very much smaller, sharper, and more distinctly defined. *N. vittata*, Gm., which in other respects is quite different, has the same pillared umbilicus with carinated edge, which is, indeed, not unusual in the genus.

2. NATICA ATYPHA, n. sp. (*ἄτυφος*, unpretending.)

St. 188. Sept. 10, 1874. Lat. 9° 59′ S., long. 139°42′ E. W. of Cape York, S.W. of Papua. 28 fms. Mud.

Shell.—Depressedly conically globose, umbilicate, spire little exserted, smooth, of a pale, faintly ruddyish white, with an obscure, broad, rusty band above the periphery. *Sculpture.* Longitudinals—there are many slight, hair-like, faintly sinuous lines of growth, which towards the suture are gathered into puckerings, and become stronger towards the umbilicus. Spirals—the whole surface is very faintly superficially and unequally furrowed, and is also slightly microscopically and regularly scratched. Within the umbilicus, but finally running out with a twist to the point of the pillar, is an indistinct and blunt circumumbilical carina. *Colour* ivory-white, with a faint tinge of buff, hardly glossy; from the periphery to within one third of the whole distance to the suture there extends a broad, pale ruddyish-purple band, whose colour deepens on the spire to the apex. *Epidermis*: none visible. *Spire* short, the separate whorls being little prominent. *Apex* rather large and tumid, but depressed. *Whorls* $4\frac{3}{4}$, the first $1\frac{3}{4}$ of which are embryonic; they are well rounded and tumid, of slow and regular increase. *Suture* nearly horizontal, but more oblique towards the mouth, not deep, but slightly channelled. *Mouth* slightly oblique, nearly semicircular, but a little pointed above, about three fourths of the total height, open, slightly angulated at the umbilical carina, pure white within, but with a very faint tinge of rust at the band. *Outer lip* open, thickish and blunt, a little flattened above where it leaves the body-whorl; its curve is very equable throughout. *Inner lip* porcellanous white, straight, little oblique, reverted, thickish, with a minute ledge within the edge of the mouth; its upper corner has a largish, slightly projecting pad, with a slight shallow channel between it and the edge of the outer lip; below this pad the inner lip slightly retreats, but at the large white pad which fills the upper part of the um-

bilicus it advances very prominently, with a strongly defined edge; below this pad it retreats sharply to the pillar, forming a nick on the left side of the pillar; below this it is again thickened and expanded at the umbilical carination. *Umbilicus* funnel-shaped, narrowed rather than defined by the umbilical carina; it is half concealed and within reduced to a mere pore by the heavy twisted umbilical pad. H. 0·43. B. 0·45. Penultimate whorl, height 0·11. Mouth, height 0·35, breadth 0·26.

This species resembles *N. phytelephas*, Rve., from Australia; but in that species the spire is not so much exserted, the umbilicus is open, circular, pervious, and spirally lirate. It is perhaps nearest to *N. plicatula*, Nuttall, from China, but is much more depressed, has the earlier whorls smaller, and though the umbilicus is like it is much larger though more closed by the interior pad. *N. Raynoldiana*, Récl., has (?) the same kind of umbilicus, but the front of the body-whorl is shorter and the apex is much finer.

3. NATICA PSEUSTES, n. sp.

July, 1874. Levuka, Fiji. Shallow.

Shell.—Rounded, with no angulation in the whole contour, obliquely depressedly globose, with spire scarcely projecting, thin, smooth, glossy, porcellanous white, with a zone of large chestnut irregular spots below the suture; the umbilicus and pillar are uniformly stained with the same colour. *Sculpture.* Longitudinals—there are many delicate hair-like lines of growth, which are strongest and most crowded near the suture and round the umbilicus. Spirals—there is a very faint appearance of rounded threads and furrows, one of which below the suture is a little stronger than the rest; besides these the surface is densely, delicately, sharply, microscopically scratched; these scratches are strongest on the upper part of the last whorl near the mouth, where their intersection with the lines of growth produces a very delicate sharp cross-hatching. The centre of the base has a scarce perceptible carination, which becomes stronger just behind the point of the pillar; within this carination is a strong but shallow umbilical furrow, which deeply cuts in on the pillar, and curves round the base of the strong pad which chokes up the umbilicus. *Colour* semitransparent, porcellanous white, which becomes a dead white round the umbilicus and also in a broadish band below the suture; this white band is flecked with irregular sharply defined, ruddy chestnut spots; a stain of this colour in

a lighter shade suffuses the whole umbilicus and pillar: the rest of the shell is covered with a delicate network of fine, sharply defined light-chestnut lines; amidst this network are two or three spiral zones, where the brown lines are sparser and pale lanceolate spots appear. *Epidermis*: none visible. *Spire* scarcely raised, but just perceptibly conical. *Apex* rather large, with the extreme rounded tip appearing at the highest point of the shell. *Whorls* $4\frac{3}{4}$ (of which the first $2\frac{1}{4}$ are embryonic and glassy), very flatly rounded, of rather slow increase. *Suture* almost horizontal and very slight. *Mouth* very oblique, semicircular, but pointed above and rounded below, with a slight angulation at the front of the pillar; the filling up of the superior corner by the labial pad equalizes the two extremities and reduces the opening to an unequal-sided oval; its entire height is about $\frac{10}{11}$ of the whole height of the shell; it is open, transparent porcellanous white within. *Outer lip*: it advances slightly on leaving the body-whorl, but beyond the pad retreats a very little, and from this point its whole curve is very equable; its edge is blunt and rounded. *Inner lip* very slightly concave; at the upper angle of the mouth it is formed by a thick transparently porcellanous pad, which is faintly tinged with chestnut: this pad projects beyond the plane of the mouth in a point, which is separated from the outer lip by a little triangular depression; it is continued with an uneven surface across the body, and unites with the pad which closes the upper part of the umbilicus, and is connected with the great chestnut-coloured spiral buttress which chokes up the umbilicus, below which the narrow umbilical furrow cuts deeply into the thickness of the pillar, whose edge is bevelled off from without and from within; towards its point the pillar is thickened by the feeble circumumbilical carina, which is rather suddenly developed and made distinct at this point. *Umbilicus* consists only of the channel or gutter, which twists round the pillar callus and disappears behind it. H. 0·327. B. 0·36. Penultimate whorl, height 0·075. Mouth, height 0·29, breadth 0·16.

Brazier, in the Chevert Exped. Marine Shells, Proc. Linn. Soc. N. S. Wales, 1877, i. p. 237, gives what is, I suppose, this species under the name of *Lunatia variabilis*, Récluz, and ascribes as its habitat N. and N.E. Australia and New Caledonia, 5–30 fms. In the British Museum there is a *Natica* presented by M'Andrew, and in his handwriting and initialed by him it is attested to come from Suez; probably it was his own dredging there (see his

Report on Suez dredgings, Ann. & Mag. Nat. Hist. 1870, vi. p. 437). It bears the name *N. marmorata*, H. Adams*. With that shell the 'Challenger' species described above is identical. But *N. marmorata*, H. Ad. (P. Z. S. 1869, p. 274, pl. xix. fig. 8) is certainly a mere synonym for *N. variabilis*, Récl.; and consequently the present species, which has hitherto passed for Adams's *N. marmorata*, requires both an individual name and a description, for it is beyond doubt distinct, though at first sight deceptively like, and, indeed, from this very fact the name proposed for it is borrowed.

Compared with *N. variabilis*, Récl., *N. pseustes* is a broader and flatter shell, with a more depressed spire; the apex is blunter, the embryonic whorls are $2\frac{1}{4}$ instead of 3 and are larger. Its coloration is very like that of *N. variabilis*, especially in the white band with large chestnut spots below the suture; but it has these spots less confluent, more ruddy, and there is none of the purple tinge on the spire which is traceable in that other. The coloured ornamentation in *N. pseustes* is a distinct network of minute, sharply defined, delicate lines, amidst which occur two or three spiral zones of lanceolate white spots where the brown lines are fewer. In *N. variabilis*, on the other hand, this coloured ornamentation is rather a mass of confused blotchy stains, with one or two spirals of brown arrow-heads parted by little white dots. There are very many other minute differences; but perhaps the best distinctive feature of all is that, when looked at perpendicularly to the centre of its axis, with the shell on its mouth and the base toward the observer, the oblique line of the base is in *N. pseustes* quite continuous and unbroken, while in *N. variabilis* in all stages of growth this basal line is abruptly interrupted by the projection of the pillar and the sweep of the basal lip.

4. NATICA SUTURALIS, n. sp.

St. 149 D. Jan. 19, 1874. Lat. 49° 32′ S., long. 70° 0′ E. Balfour Bay, Royal Sound, Kerguelen's Land. 60 fms. Mud.

Shell.—Conic-oval, thin, umbilicated, with a coarse, brown epidermis, suture channelled. *Sculpture.* Longitudinals—the surface is covered with fine, close-set, hair-like striæ, indicating lines

* M'Andrew in his Report (*l. c.*) gives "H. Adams" as his authority for this identification, but adds that "Mörch questions the species being identical." The identification being erroneous, M'Andrew's citation of the Canaries for the Suez species must be suppressed.

of growth. Spirals—there are a good many faint flexuous lines, and very obsolete but broader furrows. *Colour* apparently yellowish white, but there is a very persistent, dull ruddyish-brown *epidermis*, in which there are narrow longitudinal lines of lighter and darker shade. *Spire* high and scalar, each whorl rising high out of the one below. *Apex* quite worn away in both specimens. *Whorls* 4½, tumid, large from the beginning and of slow increase. *Suture* not very oblique, channelled. *Mouth* very slightly oblique to the axis, semicircular, but a little slewed, so as to be very slightly pointed above, and unduly bulging below beyond the point of the pillar; it is two thirds of the total height of the shell. *Outer lip* retreats somewhat on leaving the body-whorl, and at this part is slightly contracted, but below this it is open and its curve is very regular; there is a very faint tendency to angulation on the base; its edge is narrow and sharp. *Inner lip* straight till it strikes the base of the shell, where it curves with a full rounded sweep to the right; it is carried across the body on a thickish, prominent, reverted layer, crosses the umbilicus with a thin reverted edge, which half covers the opening, and is thickened and rounded, with a narrowed edge at the point of the pillar. *Umbilicus* is a funnel-shaped opening, very much contracted and concealed by the reverted pillar-lip. H. 0·7. B. 0·63. Penultimate whorl, height 0·22. Mouth, height 0·47, breadth 0·38.

This species has so strongly the aspect of *Natica islandica*, Gm. (=*helicoides*, Johnston,=*canaliculata*, Gd.,=*cornea*, Möller, out of which and the two latter synonyms Messrs. Adams form their genus (=Mörch's subgenus) *Amauropsis*, characterizing it by a feature which the species has not, viz. the absence of an umbilicus), that I can easily believe connecting links will yet establish their identity. The age of *N. islandica* and its distribution, as well as its present habitat in Subarctic and Arctic seas, make its presence in Antarctic regions more probable. But for the present it is impossible to unite them. *N. suturalis* has an epidermis which, though minutely marked very much like that of *N. islandica*, is coarser, darker-coloured, and more fibrous; the form of the shell is broader; the spire is lower, less scalar, with a less deeply channelled suture; the mouth is much rounder and is less pointed below.

5. Natica radiata, n. sp.

North Atlantic, April or May, 1873. Over 1000 fms.

St. 33. April 4, 1873. Lat. 32° 21′ 30″ N., long. 64° 35′ 55″ W. Bermudas. 435 fms. Coral-mud.

Shell.—Strong, conically globose, with a high scalar spire, laterally compressed, so that its outline is peculiarly square; mouth small; umbilicus open, deep, and funiculate. *Sculpture.* Longitudinals—there are many, unequal, but generally fine lines of growth, which are strong above, and there radiate like curved spokes from the suture; they are sharpest and highest on the earlier whorls; on the base they are again stronger, and on the edge of the umbilicus they are sharply bent back, and form there an indistinct carina. Spirals—the whole surface is covered with very faint and narrow obsolete lines and furrows, over which is a minute system of sharp microscopic scratches. *Colour* polished porcellanous white, with an indistinct and indefinite staining of buff below the shoulder and round the outside of the umbilicus. *Epidermis*: within the umbilicus are remains of a rather strong, thinnish, smooth, but puckered, blackish-yellow membrane. *Spire* high, scalar. *Apex* large, tumid, but with the extreme tip a very little bent down. *Whorls* 5, of which $1\frac{3}{4}$ are embryonic and glossy, rounded and rising high, each above the preceding one; they are laterally compressed so as to give a peculiar character to the shell, which is angulately shouldered below the suture, and tumid and broad at the base. *Suture* oblique, impressed, but not channelled. *Mouth* very small for the genus, very oblique, semicircular, but reduced by the large superior labial pad to a flat-sided oval, deep, not open; its height is less than three fourths that of the whole shell. *Outer lip* narrow, but strong; it rises a very little at its junction with the body, retreats a good deal throughout its whole very equable sweep, till on the base towards the point of the pillar it very slightly advances, and there alone is a very little patulous. *Inner lip* oblique, very slightly concave; on the body it is formed by a large porcellanous white pad projecting in a rounded knob, between which and the sharp edge of the outer lip is a small shallow depression; retreating and becoming thinner on the body, this pad projects prominently across the shell above the umbilicus, which it somewhat covers, but a furrow above the umbilical pillar cuts in on it; it spreads out in a half-circle on the point of this umbilical pillar; below this point another umbilical furrow cuts still deeper into it, but toward the point of the pillar it is broadened and reverted on the thickening of the slight circumumbilical carination. *Umbilicus* strong and

deep, narrowed by the overspread of the pillar-lip and by the strong, twisted, umbilical pillar, but helped by the strong furrow above and below this pillar. H. 0·42. B. 0·3. Penultimate whorl, height 0·13. Mouth, height 0·3, breadth 0·16.

This species is very peculiar in the squareness of its outlines, arising from an oblique lateral compression. When the shell is laid on its face a very slight angulation at the middle of the mouth is the only thing which breaks the whole basal profile. It has a slight resemblance to the young of *N. islandica*, Gm., especially in the form of the spire; but is very obviously different, being more compressed, with a much broader and shorter base.

6. NATICA AMPHIALA, n. sp. (*ἀμφίαλος*, sea-girt.)

St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40° F.

Shell.—Thick, depressedly globose, with a small scalar, rather elevated spire, and a narrow obliquely pointed base; pale yellow, umbilicated. *Sculpture.* Longitudinals—there are many fine close-set lines of growth. Spirals—there are a few faint traces of obsolete lines and furrows; there is a slight angulation round the mouth of the umbilical pore. *Colour* is slightly brownish yellow, but is pure porcellanous white below the *epidermis,* which is thin, slightly puckered, smooth, not glossy, persistent. *Spire* short, but abrupt and scalar. *Apex* seemingly rather large, but abraded. *Whorls* 4–5, narrow, flatly rounded, of gradual increase to the last, which is disproportionately large, especially toward the mouth. *Suture* strong, slightly channelled, almost quite horizontal. *Mouth* large, oval, very little oblique, and rather straight, scarcely pointed above; it is more than two thirds of the whole height. *Outer lip* sharp, but strong, patulous throughout. *Inner lip* straightish, but slightly concave in its whole length; it is expanded on the labial callus, which is thick, but has no labial nor umbilical pad; the front of the pillar is thickened and flattened back on the very indistinct circumumbilical carina. *Umbilicus* is a rather coarse, pervious, smallish round hole, hardly encroached on at all by the inner lip. *Operculum* membranaceous, thinnish, of a yellow colour, with a dark-maroon outer edge which does not quite coil in to the centre. H. 0·27. B. 0·25. Penultimate whorl, height 0·07. Mouth, height 0·21, breadth 0·17.

This species combines a flattened globose form with a pro-

minent pointed base and a small raised scalar spire, in a way that is very peculiar, so much so, indeed, that it almost recalls an *Amphibola*. *A. tenuis*, Gray, in particular, has features of resemblance. It very slightly resembles *N. nana*, Möller, from Greenland; but the body-whorl is more depressed, the spire is more exserted, and the umbilicus is not closed, as in that species.

7. Natica leptalea, n. sp. (λεπταλέος, delicate.)

St. 23. March 15, 1873. Lat. 18° 24′ N., long. 63° 28′ W. Off Sombrero Island, St. Thomas, Danish West Indies. 450 fms. *Globigerina*-ooze.

Shell.—Delicate, depressedly globose; spire slightly scalar, but with a flat round apex, thin, smooth and glossy, ivory-white, umbilicated. *Sculpture.* Longitudinals—very delicate hair-like lines of growth. Spirals—the whole surface is covered with very faint, minute, and superficial lines and furrows, complicated with sharper wavy microscopic scratches; the two so run into one another that it is difficult to say how far they are distinct, only they are so. *Colour* uniform ivory-white. *Epidermis*: none visible. *Spire* rises in a series of rounded steps from the inferior whorls. *Apex* large, but depressedly rounded. *Whorls* $4\frac{1}{4}$; the first $1\frac{1}{4}$ are embryonic, tumid, and equably rounded, of rather rapid increase. *Suture* very little oblique, slightly channelled. *Mouth* very oblique, roundly oval to circular, with a flattening of the left side; its height is rather more than five sevenths of the whole height. *Outer lip* open and well rounded throughout its whole sweep; its edge is thin. *Inner lip* is flatly curved; it spreads thinly across the body, is thinly reverted on the umbilicus, which it narrows but does not close, retreating at this point gradually to the pillar, where it is slightly nicked by the intraumbilical furrow; below this it is a little thickened and reverted throughout the length of the pillar. *Umbilicus*, which is small and funnel-shaped at its mouth, is not defined by any carina; within it is a slight furrow; it is half covered by the reverted lip, and contracts at once to a mere pore. H. 0·35. B. 0·33. Penultimate whorl, height 0·11. Mouth, height 0·26, breadth 0·2.

This species resembles some of the more flattened forms of the young of *N. Montagui*, Forb.; but than that species this is less globose, more depressed, with a higher, shorter, blunter spire, the apex of which has much coarser whorls; the mouth is much larger, more circular, and is not obliquely turned in under the

base of the body-whorl, as it comparatively is in *N. Montagui*. The umbilicus, too, is less open, and there is no trace of the umbilical pillar and superior furrow of that species. Than *N. bulbosa*, Rve., this species is rounder in the mouth, higher in the spire, and opener in the umbilicus.

8. Natica xantha, n. sp. (ξανθὸς, yellow.)

St. 150. Feb. 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E. Between Kerguelen and Heard Island. 150 fms. Rock. Bottom temperature 35°·2.

Shell.—Strongish, conically globose, slightly pointed below at the base of the mouth, glossy, bright yellow, but whitish around the umbilicus, which is a mere cleft. *Sculpture.* Longitudinals —there are very slight, rather unequal, hair-like lines of growth. Spirals—the surface is covered as usual with extremely faint superficial wavy lines and furrows, besides which is a system of still more superficial microscopic sharp straight scratches, which it is very difficult to see at all. *Colour* pure porcellanous white under the brilliant yellow *epidermis*, which is very thin, glossy and rather persistent. *Spire* high, but blunt at the top, which is somewhat eroded. *Apex* large, bluntly rounded. *Whorls* 4, the first one is large, and the shell increases very regularly; they are tumid and regularly rounded, and rise high above the succeeding ones; there is a slight and narrow swelling below the suture, with a very slight and shallow compression of the shell below this swelling. *Suture* channelled, but not broadly nor deeply so; it is considerably and increasingly oblique. *Mouth* large, open, broadly oval, with a slight flattening of its curve on the left side; its upper corner is very accurately rectangular. *Outer lip*, open but not very patulous, is a most regular curve in its whole sweep, which passes almost without change into the curve of the pillar. *Inner lip* is very slightly concave, till towards the front of the pillar it curves round to the right to meet the outer lip; a very slight pad fills up the upper edge of the mouth, a very thin transparent and straight-edged callus carries it across the body; over the umbilicus it is slightly thickened and a good deal reverted; at the point of the pillar, where it becomes adherent, it is encroached on very slightly by a small furrow, which runs out of the umbilicus parallel to the pillar; below this point the lip has a narrow, rounded, and expanded edge. H. 0·54. B. 0·47. Penultimate whorl, height 0·23. Mouth, height 0·42, breadth 0·3.

This *Paludina*-like form resembles no *Natica* known to me. It is narrower, longer in the last whorl, and higher in the spire than the most exceptional forms of *N. affinis*, Gm., var. *clausa*, Brod. & Sow. Philippi, in Küster's Mart. & Chem., reproduces pl. vii. 1, *N. limbata*, d'Orb., Patagonia, and pl. vii. 2, *N. isabelliana*, d'Orb., from South America, which vaguely have somewhat of the same features, and his *N. tenuis*, pl. xiv. 3, has so too; but these are species I do not remember to have seen, and none of the descriptions apply.

9. Natica prasina, n. sp.

St. 149 d. Jan. 19, 1874. Lat. 49° 32′ S., long. 70° E. Balfour Bay, Royal Sound, Kerguelen. 60 fms. Mud.

St. 149 e. Jan. 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Conically globose, rather high in the spire, with umbilicus closed, thin, with a pale green roughish epidermis. *Sculpture.* Longitudinals—there are on the lines of growth slight puckerings of the fibrous epidermis. Spirals—there are some slight, open, irregular, and unequal furrowings of the surface, with microscopic scratchings. *Colour*: a pale buff colour below the dull greenish *epidermis*, which is fibrous, thin, easily rubbed through, but persistent. *Spire* more or less high, the whorls rising very considerably above each other in high rounded steps. *Apex* extremely large for the size of the shell but not prominent, being rounded, with the extreme tip sunk in and generally eroded. *Whorls* 5, of which about 1¼ are embryonic; they are globose, and increase regularly and slowly. *Suture* deep, very slightly channelled, straight, but towards the end a little oblique. *Mouth* large, open, circularly oval, little oblique, right-angled above, fully rounded below, with a scarcely perceptible angulation towards the point of the pillar, slightly flattened on the inner lip; its height is nearly seven ninths of the whole height. *Outer lip*—leaving the body-whorl at a right angle, it sweeps round very fully and regularly to the pillar; it is thin. *Inner lip* a little hollowed, with, on the body, a very slight projection; there is scarcely any pad at the upper corner of the mouth, and the callus is very thin on the body; above and at the umbilicus it is thinly and somewhat broadly reverted, so as quite to conceal the opening or to leave at most a mere chink; at the pillar it narrows, and there is at this point a slight transverse angulation; the pillar is the only part of the lip which is at all thickened, and that but slightly; the edge is rounded and

slightly levelled back. *Operculum* is membranaceous, thin, with a distinct and slightly impressed suture, and scored with sharp radiating lines. H. 0·64. B. 0·53. Penultimate whorl, height 0·15. Mouth, height 0·49, breadth 0·47.

N. globosa, King, from the Straits of Magellan, is somewhat like this, but has a much more depressed spire and longer mouth. Prof. v. Martens was good enough to compare this species for me with his *N. grisea*, and from that he says "it differs (1) by being considerably larger, (2) thinner, (3) penultimate whorl less prominent, (4) the last whorl, when seen from the dorsal side, is higher or longer relatively to the breadth, (5) the umbilicus is narrower; I think, therefore, that it is a distinct species, and I see also no other in the Berlin collection which might be identical."

10. Natica fartilis, n. sp.

St. 145. Dec. 27, 1873. Lat. 46° 43′ S., long. 38° 4′ 30″ E. Between Marion Island and Prince Edward Island. 50–150 fms. Grey sand.

St. 149 d. Jan. 19, 1874. Lat. 49° 32′ S., long. 70° E. Balfour Bay, Royal Sound, Kerguelen. 60 fms. Mud.

St. 150. Feb. 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E. Between Kerguelen and Heard Island. 150 fms. Rock. Bottom temperature 35°·2.

Shell.—Globose, with a rather high spire and a somewhat elongated and pointed base, thin, with a delicate light-green epidermis; umbilicus closed. *Sculpture.* Longitudinals—the lines of growth are fine, hair-like, close-set striæ. Spirals—the surface is somewhat distinctly, though finely, scored with shallow furrows and faint lines, which are microscopically crimped; below the suture the whorls are compressed by a broad very shallow furrow, the lower side of which is very doubtfully angulated. *Colour* porcellanous white under the delicate, slightly glossy epidermis, which is pale green, streaked on the lines of growth with darker green; the umbilical pad, pillar, and inside are dead white. *Epidermis* is a thin, rather persistent smooth membrane. *Spire* is rather high and conical. *Apex* rather large, raised so that the extreme tip projects, but rounded though not flattened. *Whorls* 6 (of which the first 1½ are embryonic); they are scarcely rounded between one suture and the next, with a slight and narrow margin below the suture, then very slightly compressed; the last is very large and tumid in proportion to the rest, which project very little above it; they are of slow and very regular

increase to the last, which quite swallows up all the others. *Suture* nearly horizontal, small, not at all impressed, but very distinct, being slightly channelled, and being defined by the small margin and compression of the whorl below it. *Mouth* large but not very open, semicircular, oblique, almost right-angled above, rounded below; the swell of the body-whorl is just perceptible within; its height is more than seven ninths of the whole height. *Outer lip* very regular all the way round, its edge is thin. *Inner lip* a little flexuous; the upper corner of the mouth is filled up with a thinnish but broad pad, whose edge crosses the body in a slightly concave line; below the umbilicus, which it completely covers, it is contracted in on the pillar, which is thickish, rounded, and towards the point levelled back. *Operculum* testaceous, scored with slightish radiating lines; the spire is membranaceous, being left uncovered by the limy coat; but the one specimen which preserves the operculum is a young shell. H. 0·9. B. 0·75. Penultimate whorl, height 0·19. Mouth, height 0·73, breadth 0·52.

This species so closely approaches *N. affinis*, Gmel. (=*N. clausa*, Brod. and Sow.), that I have hesitated very much to separate them, and have been glad to be strengthened in so doing by the opinion of Prof. v. Martens and of Mr. E. A. Smith. *N. fartilis* is more globose, higher in the spire, longer and more pointed in the base, and less obliquely transverse in its outline; its apex is larger and slightly more prominent. *N. globosa*, King, from Magellan, like this in form, is umbilicated and has a thin operculum.

11. Natica apora, n. sp. (*ἄποροs*, impervious.)

St. 191. Sept. 23, 1874. Lat. 5° 41′ S., long. 134° 4′ 31″ E. Off Arru Island. 800 fms. Mud. Bottom temperature 39°·5.

Shell.—Conically globose, pointed on the base, with a pointed apex and a very slightly impressed suture; smooth but not glossy, buff-coloured, with white pillar-lip; umbilicus quite closed. *Sculpture.* Longitudinals—close-set, regular, hair-like lines of growth, which above near the suture are gathered into radiating puckers; these are strongest on the upper whorls. Spirals—there are traces of very slight furrows and obsolete lines, which are somewhat stronger and more regular on the base. *Colour*: below the ruddyish-yellow epidermis the shell is porcellanous white. *Epidermis* thin, finely fibrous, persistent. *Spire* rather high and conical, its outline being hardly broken by the rounding of the whorls and the sinking in of the sutural lines. *Apex* large,

but, being eroded, the extreme tip is much effaced. *Whorls* 5, very little rounded, and, though flattened, not at all constricted below the suture. *Suture* oblique, scarcely at all impressed, but very slightly channelled. *Mouth* very oblique from the front backwards, but in its own direction very straight in the line of the shell's axis ; oval, pointed above, and there slightly narrowed, fully rounded below ; a considerable pad fills its upper corner ; it is over four fifths of the whole height of the shell. It is slightly contracted above, and is not very open below ; and is altogether rather small for the shell. *Outer lip* is a little flattened above ; but from this forms a full round sweep. *Inner lip* slightly concave ; the moderate pad which fills the upper corner of the mouth is divided from the edge of the outer lip by an angular furrow, below which a slight tubercular swelling runs out with a slight downward direction ; the pad spreads widely and thinly across the body, and covers the umbilicus so as to leave of it only a mere chink ; below this it narrows, but without any sudden contraction, to the somewhat thickened pillar, which is bevelled off to a narrow rounded edge, which is continued round on the base to meet the outer lip. H. 0·57. B. 0·45. Penultimate whorl, height 0·15. Mouth, height 0·41, breadth 0·3.

This species belongs to the *Amauropsis* group ; but I know none with which to compare it. It is much higher and narrower than *N. impervia*, Phil., from Magellan Straits. There is a species of *Natica* from St. 169, N.E. from New Zealand, 700 fms., which may perhaps be this species ; but it is in too bad condition for identification.

ONISCIA, *Sow.**

ONISCIA CITHARA, n. sp.

St. 192. Sept. 26, 1874. Lat. 5° 49′ 15″S., long. 132° 14′ 15′ E. Kê Islands, west of Papua. 140 fathoms. Mud.

Shell.—Harp-shaped, being narrow below and broadish above ; it has a somewhat raised and sharp-pointed apex, and is scored by many mucronated ribs and broad low spirals. *Sculpture.* Longitudinals—on the last whorl (but the shell is not quite adult) are 17 rather low, flexuous, narrowish, rounded ribs which are slightly crested on their front side ; they are a little concave above, almost straight or very faintly convex for the most of their

* I do not feel called on to disturb this well-known name in favour either of *Lambidium*, Link, 1807, or of *Morum*, Bolten, 1798.

course, and retreat rather strongly so as to become horizontal as they die out on the pillar; they are parted by shallow flat furrows of unequal breadth, but greater than that of the ribs; over the whole surface, but especially in the furrows, are sharp puckerings with finer folds between, and close-set, sharp, almost microscopic striæ in the lines of growth; on the upper whorls the ribs are fewer and sharper. Spirals—on the last whorl there are 13 broad, low, squarish, raised bands, which are narrower and sharper on the snout: the first is at the suture; the second, a little remote, is narrower, but sharper than the rest; this and the third rise on the longitudinal ribs to high, narrow, sharp spikes which are parallel to the axis of the shell; the lower row of these is the larger, and they give the appearance of a shoulder: the spirals are most squarely prominent on the ribs, but are faintly continuous in the intervals; they are parted by square furrows of the same breadth as themselves; the surface of the shell is also finely scratched: below the spiral bands is a broad low swelling which curves round the pillar; it indicates the old canal, the former concave lines of whose edge form strong scores across it. *Colour* pale buff, with faint chestnut mottlings, which are concentrated and darkened in two distinct deep-purple bands in the middle of the last whorl, with fainter traces of two more below and another above near the suture; all these are vague in their limits. *Spire* raised, conical, scalar. *Apex* small, consisting of 3¼ embryonic whorls, which are polished, turbinated, and end in a fine, round, raised point; they are slightly iridescent; where they join the normal whorls there is indication of that thickening of the lip which is common in the embryonic shell of *Cassis*. *Whorls* (on the not quite adult specimen) 8, exclusive of the embryonic whorl; they rise high and constrictedly on each previous whorl, of which they leave but little uncovered; they are of very slow increase, the last is very little tumid, and that almost entirely above, its greatest breadth being at the third spiral; still they are convex throughout till near the point of the base, when the contour-line is slightly hollowed in passing over to the prominent but not lengthened nor narrow snout. *Suture* is a fine, angularly impressed, irregular line, much disturbed by the buttress-like ribs. *Mouth* long and narrow (but immature), pure porcellanous white within, but stained with the purple bands. *Outer lip* leaves the body at a right angle, but turns almost immediately to run parallel to the axis, thus forming a short narrow canal; from this point it

curves equably to the point of the shell, which is obliquely cut off upwards, forming a broad open canal. *Inner lip* spreads a little on the body in a porcellanous glaze, narrowing to a sharp point in front; its direction is almost straight in an oblique direction to the extreme point, being only slightly concave in the middle. H. 1·6. B. 0·9. Penultimate whorl, height 0·14. Mouth, height 1·37, breadth 0·32.

In form and colour this is very like *O. cancellata*, Sow.; but in sculpture it is different, having the longitudinals much more numerous and the spirals much less sharp, especially less projecting at their intersection with the longitudinals; the spire is much lower, the edge of the last whorl projects much less sharply, and the spiral at the shoulder does not project nearly so much as the first spiral below this point. In the upper whorls there is not the sharp reticulation as in *O. cancellata*, from the intersection of the spirals by the sharp longitudinals. In that species, too, the embryonic apex is quite different, being a coarse flattened blob, much larger, and having at the outside only $1\frac{3}{4}$ whorls.

O. grandis, A. Ad., is much rougher, the spirals are more numerous and higher, the spikes on the spire are not so strong, nor do they run parallel to the axis, and the apex has fewer whorls. *O. Denisoni*, Rve., has all the spirals mucronated at their intersection with the longitudinals.

Triton, *Lam.*

Triton philomelæ, n. sp.

St. 135 c. Oct. 17, 1873. Lat. 37° 25′ 30″ S., long. 12° 28′ 30″ W. Nightingale Island, Tristão da Cunha. 100–150 fms. Rock, shells.

Shell.—A rather high narrow cone, with a contracted base and long reverted canal, two varices on the last whorl, and a thin bristly epidermis. *Sculpture.* Longitudinals—there are about 18 straightish ribs on the last whorl, these are fewer in number on the earlier whorls; they are rounded, a little prominent, and about half the width of the shallow depressions which part them; relatively to these the varices (of which there is one on each two thirds of a whorl) are high and prominent, though narrow; the whole surface, ribs and interstices, is rather coarsely striated with finish rounded threads on the lines of growth. Spirals—the last whorl is encircled by 6 or 7 rounded spiral threads, which on the longitudinals form blunt rounded tubercles, pretty equally

parted above, they are slightly more crowded on the base; the 2nd, 3rd, and 4th feebly carinate the body-whorl; between them lie 3 or 4 slighter rounded threads, which do not form tubercles on the ribs; below these on the base are 6 other spirals, with a similar feebler spiral between them, while on the snout there are about 9 pretty equal, close-set, rounded threads which run parallel with the open slit of the canal. *Colour* porcellanous white, with chestnut on the larger spiral threads. *Epidermis* of a pale ruddy brown, thin, rising along all the spirals into distinct short, sharp bristles, which are set on small round tubercles. *Spire* high and rather narrow, scalar, conical, but with its profile lines broken by the contracted suture. *Apex* consists of four polished, but spirally threaded, white, turbinated whorls, of which the first is extremely small and somewhat immersed. *Whorls* 8–9 in all; they have a sloping flat shoulder to the second spiral, below which they are cylindrical and scarcely convex; the last whorl is more tumid and rounded than the others, but is very much and rapidly contracted to the rather small, longish, sharply conical, lop-sided, and reverted snout, which, viewed from above, projects to the left from the right side of the base. *Suture* interrupted by the ribs and scarcely at all impressed, but strongly defined by the long sloping shoulder below it; on the embryonic whorls it is slightly channelled. *Mouth* almost round, but a little angulated and slightly distorted; a long, straight, and very narrow slit of a canal runs out of it toward the left, neither narrowing nor widening from the place where it leaves the mouth; its sinistral inclination seems to give the whole snout a turn to the left. *Outer lip*: its semicircular curve is a little flattened; at the point of the mouth it turns quickly and runs quite straight to the point of the snout, where it is a little obliquely cut off; the edge is sharpish, but with a tendency round the mouth to become double, in the form of an outside and an inside lamella parted by a minute shallow furrow; it is thickened outside by the slightly remote, narrowish, rounded, almost scrobiculated* varix, which on the snout loses definiteness and becomes doubtful; within it is thickened by a strong porcellanous milky-white varix, on which project 6 to 8 tubercle-like teeth, which are slightly elongated from within outwards; this

* I use this word to recall the similar, though stronger, feature in *Ranella scrobiculator*, L.

labral varix is entirely absent at the upper angle of the mouth. *Inner lip*: its curve cuts somewhat deeply into the body-whorl, which it crosses as a thinnish, expanded, defined glaze; down the pillar it is reverted, with a slightly detached and projecting edge; towards the point of the mouth it is suddenly inverted so as to narrow and cover the canal, leaving behind it on the left a small shallow, angulated furrow whose labial side is scored with minute, blunt, interrupted lamellæ: there are 4 tubercle-like teeth on the pillar, of which the highest is often a little remote from the rest, the lowest, close to the origin of the canal, is smallest; the lip is plaited variously by the underlying spirals; near the upper corner is a single, rather obsolete tooth, which, like the rest, is a little elongated from within outwards. H. 1·15. B. 0·6. Penultimate whorl, height 0·26. Mouth, height 0·39, breadth 0·33. Canal, length 0·23, breadth 0·33.

This is a very exceptional form, and there is nothing much resembling it for comparison. It is narrower in the spire, less strongly ribbed longitudinally, with a shallower suture and much longer snout than *T. Quoyi*, Rve., = *T. viperinum*, Kiener nec Lam., which in some features it recalls. It is something like the young of *T. brasilianus*, Gould, from Rio de Janeiro; but in that species the longitudinal ribs are feebler, the spirals much stronger, and the anterior canal and the whole aspect of the mouth is very different. I have quoted this note made from the specimen thus named in the British Museum. I did not at that time remember that this species of Gould has been held to be identical (see Kobelt, 'Jahrbücher d. D. mal. Ges.' 1878, p. 244) with *T. parthenopus*, v. Salis. If this identification be correct, I can hardly understand how I should have found it like the 'Challenger' species, which suggests no resemblance to the species of v. Salis.

RANELLA, *Lam.*

RANELLA FIJIENSIS, n. sp.

St. 173. July 24, 1874. Lat. 19° 9′ 35″ S., long. 179° 41′ 50″ E. Fiji. 315 fms. Coral.

Shell.—Ovate, turreted, conical, strong, but not heavy, with a long pillar, high narrow varices, and a superior row of pointed circular-based tubercles of a dead ruddyish yellow, with a few chestnut spots and suffused but paler patches. *Sculpture.* Longitudinals—there are high, narrow, alternate varices, which on the

earlier whorls follow continuously, but rather lag behind their true place; on the body-whorl they are dislocated by being thrown considerably in front of it; the last one does not extend to the snout; there are minute, not very continuous, uneven, longitudinal threads over the whole surface. Spirals—about a third of its height below the suture the last whorl is carinated at its periphery by a row of sharp, prominent, distant, round-based tubercles, which are hardly continuous nor set on a cord; on the spire this row nearly bisects the whorls, but is a little inferior; between this row and the suture there are placed alternately 3 fine tubercled threads and 2 tubercled cords, of which latter the upper is the stronger; its tubercles and those of the thread above it at the suture tend to coalesce; less than halfway below the periphery there is a row of smaller, less prominent, more numerous, pointed tubercles set on a cord; halfway between these two rows is a cord with close-set rounded tubercles having two threads below it and a thread and a fine tubercled cord above it, which last lies on the bases of the tubercles forming the peripherial carination. On the base are four tubercled cords, the first and second of which have a fine tubercled thread above them, and the fourth a similar thread below it defining the base of the pillar; on the pillar there are 6 cords more or less tubercled, of which 3 cover the snout, two are on the underside, and one at the edge: there is little difference in the strength or arrangement of the spiral cords or tubercles above or below the periphery; they all rise into very considerable prominence and sharpness in crossing the varices. The whole shell is covered by minute threads, which form knots where they cross the rather weaker longitudinal threads, giving the surface somewhat of the texture of a fine file. *Colour* dead white, with a superficial ruddy-yellow tinge, which has a few lines and patches of deeper hue and a few spots of chestnut. *Epidermis*: only a few traces of a very thin, smooth, membranaceous skin remain. *Spire* high, narrow, and small, conical, somewhat scalar from the infrasutural shoulder, whose angularity breaks the conical outline. *Apex* consists of 3 polished, turbinated, ochraceous whorls whose tip is immersed. *Whorls* 8 to 9 in all, with a sloping flat shoulder, a carinated periphery, and a slight straight contraction from this point to the suture; the rounded base contracts quickly on the left, bearing on this side a long, prominent, bent and twisted pillar, which is lost on the right side by the out-

ward sweep of the base, which advances very far forward, but leaves a short, square, projecting snout. *Suture* distinct and deeply impressed, on the upper whorls slightly channelled. *Mouth* oval; the upper canal is distinct, but neither long, wide, nor deep; the lower canal is open and moderate in size; but the whole snout is rather exceptionally square and prominent. *Outer lip* somewhat angular in its course, thin, prominent beyond the varix, patulous internally, but externally scarcely at all reflected; it is thickened within, and has very near its edge teeth in groups of 3, 2, 2, 3, so placed as to avoid the longer spirals of the external sculpture. *Inner lip* spreads somewhat thinly and with a slightly disconnected edge across the body, it then runs straight down the middle of the pillar: at the top of the mouth a long, somewhat subdivided, and upward-curved tooth defines the canal; below this there are about 9 not very definite teeth on the body; below the last of these is a wider break, and below this on the pillar are about 6 more, rather strong at first, but steadily becoming smaller; parallel to the edge the reverted flap of the lip is prominent below the callus glaze, and finally stands out beyond this glaze as a margin to the canal. H. 2·1. B. 1·44. Penultimate whorl, height 0·45. Mouth, height to point of canal 1·2, breadth from edge of callus 0·7.

This species, better than any I know, forms a link between the *crumena* and *granifera* groups of *Ranella*. It is very near *R. nobilis*, Rve.; but the form there is much broader and the system of tubercles quite different. *R. affinis*, Brod., is very like; but in that the form is much more regularly conical, the suture, so far from being impressed, is run up on the preceding whorl, the varices run down in straight regular succession, the apex is ruddy purple, and the pillar is much shorter, thicker, and reflected. *R. ponderosa*, Rve., has near affinities in arrangement of tubercles and teeth of outer lip, but is larger in form and quite different in colour and texture. *R. rana*, L., has a much sharper apex, a much squatter form, and much more pointed tubercles. Than *R. livida*, Reeve, the 'Challenger' species is much shorter, thinner, more tubercled, its suture is more impressed, and its pillar longer and straighter. Than *R. subgranosa*, Beck, it is a much less compact form, the spire being higher and smaller, the base and suture much more contracted; the body-whorl is in all ways much smaller and shorter, but broader in proportion to height.

NASSARIA, *Link.*

NASSARIA AMBOYNENSIS, n. sp.

Oct. 6, 1874. Amboyna. 15–25 fms.

Shell.—Ovate, conical, pointed, variced, brown-banded, a very contracted base, with a short, recurved, and somewhat twisted snout. *Sculpture.* Longitudinals—there are on each whorl 11 or 12 (on the earliest about 10), strong, prominent, well-defined, rounded, curved, and sinistrally inclined ribs, of which about 2 on each whorl are stronger than the rest; these ribs extend to the base of the snout, and swell up over, but are interrupted by, the suture which at top of whorls cuts them off; they run with a sinistral twist down the spire; the rather deep interstices are fully broader than the ribs: besides these, the whole surface is roughened with slight unequal lines of growth, which are most distinct on the earlier whorls. Spirals—the surface is beset with unequal threads, of which about 6 on the body and 4 on the base are stronger and more prominent than the rest; the two in the middle of the whorls are most so of all; between these are 3, 4, or 5 unequal, raised, and sharpish round threads, especially prominent on the longitudinal ribs the hollows between these are variable in width, deep, and flat-bottomed, though sometimes filled by another minute thread; these intervals are finely scored, while the threads are coarsely roughened and crumpled by the longitudinal lines of growth: besides these, the surface is finely fretted with microscopic spirals; on the snout are about 10 coarsish somewhat crumpled threads, with minute sharp lines in their interstices. *Colour* tawny white, with a broadish, infraperipherial chestnut band and less continuous stains of the same up to the suture and on the base and snout. *Spire* high turreted, conical, small and sharp at the point, with an almost continuous outline in spite of the deep suture. *Apex* partly broken, but evidently consisting of 2 or 3 polished, rounded, turbinated whorls. *Whorls* 9, exclusive of the embryonic whorl, ventricose, rounded, of regular increase; but the last is somewhat disproportionately large; the base is rounded, but contracted and a little flattened toward the snout, which is ample, but not large, both as to length and breadth, and advances straight in the axis of the shell, but with a dextral twist and a strong backward bend on itself. *Suture*

is itself invisible, but is very strongly defined by the deep undulated furrow, which at the top of the whorls sinks in behind the longitudinal ribs and cuts them off from the base of the preceding whorl. *Mouth* oval, rather small, deep, perpendicular, and very little oblique; from its lower left corner rises a strong, deep, equal, slightly curved canal, whose direction is distinctly, but not strongly, to the left. *Outer lip*: its nearly semicircular curve is slightly flattened about the middle, and bags a little toward the lower outer corner; at its upper corner it advances a good deal and rises a little on the body-whorl; its sharp and contracted margin, which projects from the last and massive varix, is crenulated; remote from the edge it is scored by 9 rather long, narrow, sharp-topped teeth, the first and two last of which are stronger than the rest; the first is a little remote from the upper angle of the mouth, while the last is on the very edge of the canal. *Inner lip* spreads patulously, but not broadly, on the body-whorl in a thin, defined, porcellanous layer; it runs straight down the pillar as a sharp projecting edge; it is scored within by about 9 teeth, of which the first is short and strong, the second long and strong, the third and fourth long and weak, the fifth, sixth, and seventh short and weak, while the eighth and ninth are strong and coil round the point of the pillar. On the left side of the canal are 4 or 5 tubercles. H. 1·37. B. 0·84. Penultimate whorl, height 0·26. Mouth, height (exclusive of canal) 0·49, breadth 0·3. Length of canal 0·29, breadth 0·07.

This species has much resemblance to *N. acuminata*, Rve., but is shorter, squatter, coarser, with more ribs, is deeper in suture; the canal is shorter, more recurved, and more twisted.

Notes on British Tunicata, with Descriptions of new Species. I. Ascidiidæ. By W. A. Herdman, D.Sc. Edinb.

[Communicated by Sir Wyville Thomson, F.R.S., F.L.S.]

[Read December 2, 1880.]

(Plates XIV.–XIX.)

The family Ascidiidæ comprises those Simple Ascidians which have a six-, seven-, or, more generally, an eight-lobed branchial aperture and a six-lobed atrial aperture, the principal additional characters being:—body sessile, attached; tentacles simple, fili-

form; branchial sac not folded and having internal longitudinal bars. Excluding the genera *Chelyosoma* and *Rhodosoma* (*Chrevreulius*, Lac.-Duth.), which have not been found in our seas, the family, as represented by British species, corresponds to *Ascidia* as used by Forbes ('British Mollusca' &c.), and includes the three modern genera *Ciona*, *Ascidia*, and *Corella*, the first and third containing each several, and *Ascidia* a large number of species. *Ciona* and *Corella* have a series of languets along the dorsal edge of the branchial sac, while *Ascidia* has a continuous lamina; *Ciona* and *Ascidia* have the stigmata of the branchial sac straight, while those of *Corella* are curved. In addition to these and some other less important points, the three genera differ in the course and position of the alimentary canal from the œsophageal opening onwards; in *Ciona* (woodcut, fig. 1) it extends beyond the branchial sac posteriorly, while in the other two genera it lies alongside the branchial sac, on the right side in *Corella* (woodcut, fig. 2), and on the left in *Ascidia* (woodcut, fig. 3).

Alder first, in 1863 (Ann. & Mag. Nat. Hist. ser. 3, vol. xi. p. 158), pointed out that the intestine in *Corella* (then *Ascidia*) *parallelogramma*, after leaving the stomach, turned posteriorly*, and not anteriorly as in *Ascidia*. This peculiarity, however, does not affect the relation of the intestine to the hæmal system; in both cases the curve is away from the heart. Hancock, in characterizing *Corella* (Ann. & Mag. Nat. Hist. ser. 4, vol. vi. p. 362, 1870), after describing the course of the alimentary canal, stated that it was very differently disposed from that of *Ascidia*, and that the heart occupied a different position. The latter part of this statement requires modification, for although the absolute position of the heart is changed, its position relatively to the intestine is not affected, as may be seen in the following diagrams (woodcuts, p. 276).

Ciona (fig. 1) shows the simplest and probably the typical condition in which the intestinal loop (i) is completely posterior to the branchial sac (br), the œsophagus and stomach descending on the dorsal side, and the intestine ascending (for a time) on the ventral side. Here the heart, being always in connexion with the stomach, is dorsal, and the intestine lies ventrally and anteriorly to it.

* The branchial aperture is "anterior," and the oral lamina or languets "dorsal;" Hancock considered the endostyle dorsal.

Fig. 1.

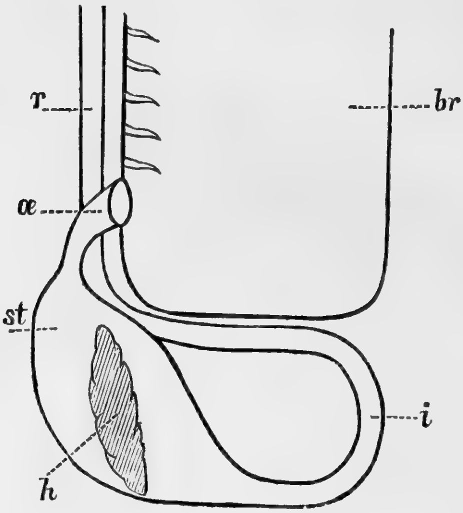


Fig. 2.

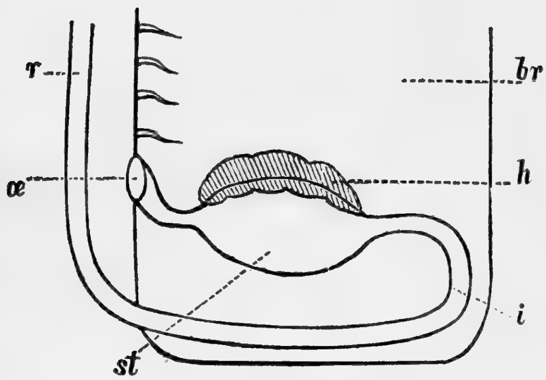
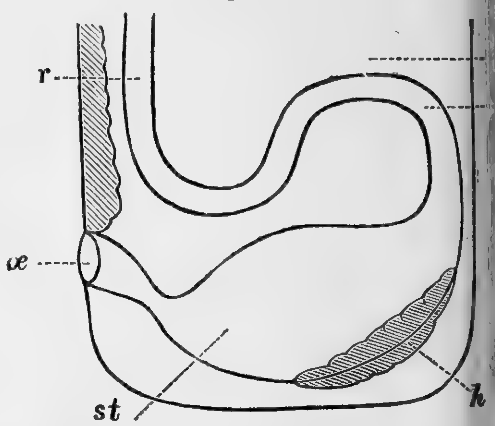


Fig. 3.



Diagrams showing course of the alimentary canal: fig. 1, in *Ciona*; fig. 2, in *Corella*; fig. 3, in *Ascidia*. *œ*, œsophagus; *st*, stomach; *i*, flexure of intestine; *r*, rectum; *br*, branchial sac; *h*, heart.

If we now, the mouth and anus being fixed, draw the intestinal loop (*i*) directly anteriorly until the whole alimentary canal is on the *left* side of the branchial sac, we get the relation of parts characteristic of *Ascidia*, as shown in fig. 3. The heart now lies at the ventral edge of the posterior end, the intestine turns anteriorly, and is in its entire extent anterior to the heart.

If we return to fig. 1, the arrangement in *Ciona*, and again draw the intestinal loop forwards, but this time to the *right* of the branchial sac, we produce the configuration shown in fig. 2, and characteristic of *Corella*. Here the heart, having remained on the stomach-wall, has become anterior to the intestine, and is

on neither dorsal nor ventral edge, while the intestine, though still curving away from the heart, turns posteriorly instead of anteriorly.

We thus see that it is possible, by a simple change in the relation of the alimentary canal to the branchial sac, to get the very different arrangements of the viscera found in the genera *Corella* and *Ascidia* from the simpler and somewhat intermediate condition which obtains in *Ciona*. This explanation also accounts for the curious position of the heart in *Corella*, and shows that it is merely a consequence of the change in the disposition of the intestine.

Some of our British species of *Ascidia* require examination; several have been described under different names by different authors, and many have never been sufficiently characterized—a full description requiring, according to our modern ideas, an account of the condition of the branchial sac, dorsal lamina, and other internal organs, as well as of the external appearance.

The new species have been dredged, during the last three summers, on the west coast of Scotland, in Loch Long (Clyde), and in Lamlash Bay, Arran.

Ascidia lata, n. sp. (Plate XIV. figs. 1–3.)

External appearance.—Shape roughly oblong, anterior end narrowest; flattened laterally; nearly erect; posterior end rounded; ventral edge convex; dorsal edge with a large rounded projection near the middle. Attached by a small oblong area at the ventral edge of the posterior end of the left side. Branchial aperture terminal or nearly so, sessile, not conspicuous; atrial aperture about halfway down, placed at the summit of the projection on the dorsal edge, not conspicuous, lobes rather indistinct. Surface smooth, but cut up by faint creases, most of which are longitudinal and on the upper (right) side; a few *Serpulæ* &c. adhering towards the posterior end. Colour yellowish grey, light at anterior end, and brownish towards posterior end and on lower (left) side. Length 9·2 centims., breadth 5·1 centims.

Test rather thin, thickish on the upper surface, and especially at the area of attachment. Vessels well-developed and conspicuous on the inner surface; trunks enter near the middle of the ventral edge.

Mantle moderately developed; musculature strong on the

right side, especially in the centre, where the bands attain a thickness of ·5 millim.; sphincters not particularly strong. Mantle very thin on visceral (left) side; no muscle-bands. No ocelli visible (spirit specimen).

Branchial sac large, extending beyond the viscera posteriorly, longitudinally plicated. Transverse vessels wide and rather close, all one size. Meshes nearly square, the transverse extent being generally slightly the greater, with large papillæ at the angles, and slightly smaller intermediate ones on the inconspicuous internal longitudinal bars. Stigmata oblong, rather short, six to eight in a mesh. All the larger vessels bear, on their outer (atrial) sides, short, more or less spine-like projections.

Dorsal lamina rather narrow, ribbed transversely, margin slightly pectinated. On the right side of the branchial sac near the dorsal lamina, and a little above the œsophageal opening, there is an oval slit 1·5 centim. long; externally it opens just inside the atrial aperture.

Tentacles few (16 to 20), distant, and rather small, filiform.

Olfactory tubercle of moderate size, irregular in shape, right horn rolled outwards and left horn inwards.

Viscera.—Stomach large, thick-walled. Intestine with a broad typhlosole projecting from the upper (inner) side. Ovary and testis placed in the loop.

Locality. Upper end of Loch Long, 5 to 10 fathoms.

This species externally bears considerable resemblance to *Ascidia mentula*; it differs from it chiefly in the character of the branchial sac, the tentacles, and the olfactory tubercle (see Plate XIV. fig. 3).

ASCIDIA FUSIFORMIS, n. sp. (Plate XIV. figs. 4–6.)

External appearance.—Shape elongate-elliptical, flattened laterally; both ends narrow, anterior almost pointed, posterior more obtuse; dorsal edge rather more convex than ventral. Attached by a small area on the left side two thirds of the way down. Branchial aperture terminal and median, almost sessile; atrial on right side halfway between median line and dorsal margin, fully halfway down, sessile; lobes of both rather indistinct. Surface smooth, a few faint mostly longitudinal creases on the right side. Colour light yellowish grey, hyaline at the edges. Length 6·5 centims., breadth 3 centims.

Test rather thick, hyaline, transparent; vessels just visible.

Mantle moderately muscular on the right side.

Branchial sac extending beyond the viscera posteriorly, longitudinally plicated (in some parts not at all strongly); meshes square or slightly elongated transversely, with stout papillæ at the corners, and smaller intermediate more conical ones. Stigmata short, generally oval or elliptical, three in a mesh.

Dorsal lamina narrow, ribbed transversely, margin bluntly denticulated.

Tentacles small and distant, 25 to 30 in number, large and small alternately.

Olfactory tubercle almost quadrangular in outline; both horns coiled inwards.

Nerve ganglion oblong, narrow, placed nearer the atrial than the branchial aperture.

Locality. Upper end of Loch Long, 5 to 10 fathoms.

This species is evidently allied to *Ascidia mentula.*

One of the three specimens is a sinistral individual. The area of attachment is on the right side, and the atrial aperture is on the left. Internally, the branchial sac is placed to the left of the viscera, so that, on opening the branchial sac from the side opposite the viscera, the anterior end being uppermost, the dorsal lamina is seen on the right hand and the endostyle on the left, the reverse of the usual arrangement.

ASCIDIA VIRGINEA, *O. F. Müller.* (Plate XV. figs. 1, 2.)

Ascidia virginea, *O. F. Müller, Prodromus,* p. 225. no. 2732 (1776), *Zool. Dan.* vol. ii. p. 12, tab. 49. fig. 4 (1780).

Ascidia opalina, *MacGillivray, Moll. Aberdeen,* p. 312 (1843).

Ascidia punum, *MacGillivray, Moll. Aberdeen,* p. 312 (1843); non *Müller, Zool. Dan.*

Ascidia sordida, *Alder, Cat. Mar. Moll. Northumb. & Durham,* in *Trans. Tynes. Nat. F. C.* vol. i. p. 199 (1850).

Ascidia virginea, *Alder, Cat. Mar. Moll. Northumb. & Durham,* in *Trans. Tynes. Nat. F. C.* vol. i. p. 200 (1850).

Ascidia virginea, *Forbes & Hanley, Brit. Moll.* vol. i. p. 33 (1853).

Ascidia sordida, *Forbes & Hanley, Brit. Moll.* vol. ii. p. 372 (1853).

Ascidia virginea, *Norman, Moll. of the Firth of Clyde, Zoologist,* vol. xv. p. 5708 (1857).

Ascidia virginea, *Grube, Die Insel Lussin und ihre Meeresfauna,* p. 53 (Breslau, 1864).

Ascidia sordida, *Hancock, Anat. & Phys. of Tun., Journ. Linn. Soc. Zool.* vol. ix. p. 309 (1868).

Phallusia virginea, *Kupffer, Jahresberichte d. Komm. z. Untersuch. d. deutsch. Meere in Kiel, Tunicata,* p. 210 (1874).

Ascidia sordida, *MacIntosh, Marine Fauna of St. Andrews,* p. 55 (1875).

Ascidia virginea, *Heller, Untersuch. ü. d. Tun. d. Adriat. u. Mittelm.* ii. Abth., p. 7 (1875).

Phallusia virginea, *Traustedt, Oversigt o. d. f. Danmark, &c., Asc. simp.* p. 45, in *Vid. Medd. Nat. For., Kjöbenhavn* (1880).

M. Traustedt, in a paper published last summer, on the Simple Ascidians from the coast of Denmark &c., has placed *Ascidia sordida* of Alder and Hancock as a synonym of *Ascidia virginea.* In this I quite agree with him. A comparison of the descriptions of *A. sordida* by Alder and of *A. virginea* by Kupffer and Heller leaves no room to doubt that they are the same species. It is rather curious, however, that Alder should have both names in his catalogue; he does not in his description of *A. sordida,* as a new species, refer to *A. virginea* at all.

A few points in regard to the characteristics of the species still require to be discussed. The external appearance has been fully described, especially by Alder and Heller. In regard to the branchial sac, the absence of papillæ (see Pl. XV. fig. 1) has been noticed by Alder, Kupffer, and Traustedt, while Heller states that the internal longitudinal bars are provided with small three-cornered papillæ. I have figured (Pl. XV. fig. 2) a small portion of the branchial sac seen from the outside, to show the appearance presented by the longitudinal plication. The dorsal fold is always described as ribbed transversely and smooth-edged. In specimens from the Firth of Forth, however, where what was described by Alder as *Ascidia sordida* is very common in 4 and 5 fathoms, the margin is slightly but distinctly toothed, there being several smaller denticulations between each pair of larger ones, which are opposite the ends of the ribs. The tentacles are described as being closely packed and about fifty in number. This is considerably under what I have observed, which has generally been about ninety; they are rather slender, and are of two sizes placed alternately.

Ascidia truncata, n. sp. (Plate XV. figs. 3–6.)

External appearance.—Shape oblong, nearly quadrangular, flattened laterally; anterior end truncated, slightly narrower than the almost straight posterior end; dorsal and ventral edges nearly straight and parallel. Attached by a narrow transverse

area at the left side of the posterior end. Apertures both on right side; branchial terminal, placed at the dorsal extremity of the anterior end, and turned dorsally; atrial close to the branchial, and directly posterior to it, being on the right side, close to the dorsal edge, and about one fifth of the way down. Both apertures slightly projecting, tubular, rather wide; atrial more distinctly and regularly lobed than branchial. Surface rough and irregular, especially on the posterior half of the right side. Several foreign bodies adhering at the base, and some specimens of *Modiolaria marmorata* imbedded in the anterior half of the right side. Lobes of apertures finely echinated. Colour yellowish grey to dark brown. Length 6·8 centims., breadth 4 centims.

Test moderately thick, tough; inner surface smooth, with a bluish tinge; no vessels visible.

Mantle well developed; muscle-bands strong, but rather distant on the right side and round the edges of the left; entirely wanting over the visceral mass, where the mantle is membranous.

Branchial sac longitudinally plicated; every third or fourth transverse vessel larger and more muscular than the intermediate ones. Internal longitudinal bars well marked, borne on long curved ducts, and bearing very small papillæ, which merely form slight thickenings at the angles of the meshes. Meshes rather elongated transversely; stigmata short, elongate-elliptical, six to eight in a mesh.

Dorsal lamina broad, ribbed transversely, and slightly pectinated at the margin.

Tentacles rather large and strong, 32 in number, longer and shorter alternating.

Olfactory tubercle regular, broadly heart-shaped; both horns coiled inwards.

Viscera reaching as far posteriorly as the base of the branchial sac.

Locality. Upper end of Loch Long, 5 to 10 fathoms.

This species is probably allied to *A. virginea.*

ASCIDIA ASPERSA, *O. F. Müller.* (Plate XVI. figs 1–3.)

Ascidia aspersa, *O. F. Müller, Prodromus,* p. 225. no. 2728 (1776); *Zool. Dan.* ii. p. 33, tab. 65. fig. 2 (1780).

Ascidia mamillaris, *Delle Chiaje, Mem. degli anim. di Napoli,* vol. ii. p. 197, tab. xlv. fig. 14 (1823).

Phallusia cristata, *Risso, Hist. nat. d. prod. de l'Eur. mérid.* t. iv. p. 276 (1826).

Ascidia aspersa, *Forbes & Hanley, Brit. Moll.* vol. i. p. 35 (1853).
Ascidia cristata, *Grube, Ausflug nach Triest &c.*, p. 65, tab. ii. fig. 8 (1858).
Ascidia pustulosa, *Alder, Ann. & Mag. Nat. Hist.* ser. 3, vol. xi. p. 154 (1863).
Ascidia aculeata, *Alder, Ann. & Mag. Nat. Hist.* ser. 3, vol. xi. p. 156 (1863).
Ascidia cristata, *Grube, Die Insel Lussin und ihre Meeresfauna*, p. 53 (1864).
Ascidia aspersa, *Alder, Hebrid. Invert., Brit. Assoc. Rep. for* 1866, p. 207 (1867).
Phallusia pustulosa, *Kupffer, Jahresberichte d. Komm. z. Untersuch. d. deutsch. Meere in Kiel, Tun.* p. 213 (1874).
Ascidia cristata, *Heller, Untersuchungen ü. d. Tun. Adriat. u. Mittelm.* 1 Abth. p. 16, Taf. vi. figs. 5–12 (1874).
Phallusia aspersa, *Traustedt, Oversigt o. d. f. Danmark &c., Asc. simp.* p. 43 (1880).

This species varies somewhat in external appearance according to its age, and there can be no doubt that Alder's *A. pustulosa* and *A. aculeata* are merely the old and young stages. Grube suggests that Delle Chiaje's *Ascidia mamillaris* is a young specimen of this species; and the figure certainly closely resembles some small specimens of *A. aculeata* from Lamlash Bay. Heller gives, under the name of *A. cristata*, an excellent account of this species; it has also been well described as *Phallusia pustulosa* by Kupffer, and as *Ascidia aspersa* by Traustedt; in some of the internal characters, however, there is a certain want of agreement between the various descriptions. In regard to the branchial sac, Alder says that *A. pustulosa* has small papillæ, and *A. aculeata* has papillæ and elliptical stigmata. Heller's description of the branchial sac is good; he refers to the longitudinal plication (like that in *Ascidia mentula*), the long connecting ducts, and the very small papillæ. Kupffer, strange to say, mentions long papillæ, equalling in length the breadth of the meshes; he may have confused them with the long connecting ducts. In all the specimens I have examined (from Lamlash Bay and Loch Long) the papillæ were very small, and, except when seen in profile, appeared as mere thickenings of the internal longitudinal bars; the meshes were small and nearly square, containing each four to six rather short stigmata (Pl. XVI. fig. 1).

The dorsal lamina, correctly described by Heller, is transversely ribbed, and has the margin finely but irregularly denticulated

(Pl. XVI. fig. 2). Alder states that it is smooth, and Kupffer and Traustedt mention the ribs, but refer to the edge as smooth.

The tentacles (Pl. XVI. fig. 3), which in my specimens are small and slender, rather distantly placed, 32 in number, and of three sizes alternating (eight large-, eight medium-, and sixteen small-sized), are described by Alder in *A. pustulosa* as few and stout, while Kupffer and Traustedt say that they number fifty or more; their relative size and arrangement is not referred to in any of the descriptions.

Ascidia triangularis, n. sp. (Plate XVI. figs. 4–7.)

External appearance.—Shape triangular, not compressed; anterior end narrow, forming a rounded point; posterior end wide, straight, elongated dorso-ventrally; ventral edge almost straight, dorsal sloping backwards to join the rounded dorsal edge of the posterior end. Attached by the entire extent of the posterior end, and the ventral half of the posterior end of the right side. Branchial aperture terminal, sessile; lobes regular and distinct, but not projecting; atrial aperture on dorsal edge, one third of the way down, slightly projecting, directed dorsally and posteriorly. Surface prickly, covered with minute pointed projections all over, except on the centre of the left side, and at the anterior end round the branchial aperture. Colour light grey; when living the apertures were slightly pink. Length 2·3 centims., breadth (at posterior end) 2 centims.

Test rather thin and soft, but moderately strong, transparent. Course of intestine seen through distinctly from left side.

Mantle delicate, adhering slightly to inner surface of test; musculature distinct but fine.

Branchial sac a little irregular, but not longitudinally plicated. The alternate transverse vessels wider than the intermediate ones. Internal longitudinal bars distinct and strong, borne on long ducts; no papillæ. Meshes almost square, containing each about six stigmata.

Dorsal lamina transversely ribbed; margin minutely denticulated, three or four denticulations between each pair of ribs.

Tentacles rather small and distant, 15 larger, and nearly the same number of small intermediate ones; in some spaces the intermediate one is absent.

Olfactory tubercle irregularly lozenge-shaped, opening anterior; horns bent in, but not coiled.

Viscera.—Stomach distinct, nearly globular; intestine rather long and narrow.

Locality. Lamlash Bay, 10 to 20 fathoms.

This species comes near *Ascidia aspersa.* In some parts of the branchial sac (Pl. XVI. fig. 6) there is an irregularity and want of continuity in the internal longitudinal bars; the same condition is seen frequently in *Corella parallelogramma.*

Ascidia scabra, *O. F. Müller.* (Plate XVI. fig. 8; Plate XVII. figs. 1–3.)

Ascidia scabra, *O. F. Müller, Prodromus,* p. 225. no. 2726 (1776), *Zool. Dan.* ii. p. 33, tab. 65. fig. 3 (1780); *Forbes & Hanley, Brit. Moll.* vol. i. p. 33 (1853).

Phallusia scabra, *Grube, Die Insel Lussin &c.* p. 55 (1864).

Ascidia scabra, *Hancock, Anat. and Phys. of Tun., Journ. Linn. Soc. Zool.* vol. ix. p. 309 (1868).

Ascidia scabra, *Heller, Untersuchungen ü. d. Tun. Adriat. u. Mittelm.* 1 Abth. p. 17, Taf. vi. fig. 13 (1874).

As far as I am aware only the external appearance of this species has been described; the following will complete what is necessary for the proper definition of the species.

Branchial sac longitudinally plicated; transverse vessels usually all of the same size, occasionally, however, slighter intermediate ones are present for short distances. Internal longitudinal bars distinct, but having no papillæ. Meshes usually transversely elongated, each containing about twelve stigmata.

Dorsal lamina broad, ribbed transversely; margin finely but irregularly toothed, five to seven teeth between each pair of ribs.

Tentacles of three lengths, 18 long and rather slender, the same number of shorter intermediate ones, and about 36 very short ones, regularly disposed between the others.

Olfactory tubercle simply oval in outline, the opening at the anterior end; horns not coiled.

Ascidia scabra is allied to both *A. aspersa* and *A. virginea.* I have figured (Plate XVII. fig. 3) a small part of the branchial sac of one of my specimens, to show the amount of irregularity which may occur; it is seen from the outer side so as to avoid the additional complication which the presence of the internal longitudinal bars would introduce.

Ascidia patoni, n. sp. (Plate XVII. figs. 4–7.)

External appearance.—Shape elongate-elliptical; anterior end narrow, posterior rounded; dorsal edge more convex than ven-

tral; left side flat, right slightly convex. Attached by posterior end of left side towards ventral edge; the area of attachment forms a well-marked base, almost a short stalk, with the posterior margin slightly expanded. Both apertures on right side, sessile; branchial almost terminal; atrial about one fourth of the way down, near the dorsal edge. Surface smooth. Colour light yellowish grey. Length 6 centims., breadth 3 centims.

Test thin, but tough; vascular trunks enter in the lower third of the left side (at the anterior end of the base), and radiate over that side, where they are conspicuous.

Mantle rather thin; muscle-bands fine, but numerous.

Branchial sac delicate, not longitudinally plicated; the alternate transverse vessels are stronger than the intermediate ones; in some places, however, the latter are wanting. The internal longitudinal bars bear large curved papillæ, those at the intersections with the slighter transverse vessels, or where these ought to be, smaller than the others. Meshes slightly longer transversely than vertically; stigmata short and regular, six to eight in a mesh.

Dorsal lamina closely ribbed transversely; margin toothed, rather irregularly.

Tentacles very numerous, packed closely together, of at least three sizes, the smallest being very minute.

Olfactory tubercle simply ovate in outline, the opening anterior.

Locality. Upper end of Loch Long, 5 fathoms.

For this and a few of the other specimens I am indebted to my friend Mr. D. Noel Paton, B.Sc., to whom this species is dedicated.

Ascidia muricata, *Heller*. (Plate XVIII. figs. 1, 2.)

Ascidia muricata, *Heller, Untersuchungen ü. d. Tun. d. Adriat. u. Mittelm.* 1 Abth. p. 13, Taf. iv. figs. 6–7 & Taf. v. fig. 1 (1874).

This species, which was found by Heller at Lesina, I dredged twice in Lamlash Bay last September. The specimens were small, being only half the size of those from the Mediterranean, but agree well with the description and figures. Heller gives a full account of the external appearance; but for the internal characters merely says that the form of the branchial sac, the papillæ, and the dorsal fold are like those of *Ascidia mentula*. I therefore add the following details taken from the Scottish specimens.

Branchial sac not longitudinally plicated, or very slightly so;

transverse vessels all one size, rather far apart. Internal longitudinal bars strong and numerous, bearing large irregularly shaped papillæ at the angles of the meshes, and smaller conical intermediately placed ones. Meshes having the vertical extent nearly twice as great as the horizontal, each containing two or three stigmata.

Dorsal lamina rather broad, strongly ribbed transversely, margin plain.

Tentacles rather large, placed close together, long and short alternately, about 12 of each size.

Olfactory tubercle simple, opening anterior, horns not coiled.

ASCIDIA OBLIQUA, *Alder*. (Plate XVIII. fig. 3.)

Ascidia obliqua, *Alder, Ann. & Mag. Nat. Hist.* 3rd ser. vol. xi. p. 154 (1863).

In the collection at the Natural-History Rooms in the Edinburgh University there are two specimens of this species from Lofoten, 300 fathoms, identified by Professor M. Sars; they agree perfectly with Alder's description of British specimens (Lamlash). Those, on the other hand, described and figured by Heller (Untersuch. &c., 1 Abth. p. 13, Taf. iv. fig. 5) are undoubtedly a distinct species.

Alder gives a good description of the external appearance; an account of a few points in the internal structure is still wanting.

Branchial sac delicate, longitudinally plicated. Internal longitudinal bars thin but distinct, bearing papillæ at the corners of the meshes; these papillæ are rod-like in profile, but bear membranous expansions, which are seen in the lateral view. Meshes slightly longer vertically than transversely, each containing about six elongated regular stigmata.

Dorsal lamina transversely ribbed.

Tentacles numerous, slender.

Olfactory tubercle cordate.

ASCIDIA DEPRESSA, *Alder & Hancock*. (Plate XVIII. figs. 4, 5.)

Ascidia depressa, *Alder, Catalogue of the Marine Mollusca of Northumberland and Durham, in Trans. Tynes. Nat. F. C.* vol. i. p. 201 (1850); *Forbes and Hanley, British Mollusca,* vol. ii. p. 373 (1853); *Alder, Hebrid. Invert., Brit. Assoc. Rep. for* 1866, p. 208 (1867); *Heller, Untersuch. ü. d. Tun. d. Adriat. u. Mittelm.* 1 Abth. p. 15, Taf. v. figs. 10–12 (from *Denksch. d. k. Akad. d. Wiss.* Bd. xxxiv., Wien, 1874) *MacIntosh, Marine Fauna of St. Andrews,* p. 55 (1875).

This species has such a characteristic appearance that no addition to Alder's description is necessary. No account of its internal characters, however, has been given—Alder merely saying "Branchial sac finely reticulated, with tubercules at the intersections," and Heller giving no information beyond the external appearance. This being the case, the following notes on the condition of the branchial sac &c. are necessary to complete the description of the species.

Branchial sac long and narrow, generally extending beyond the viscera posteriorly, longitudinally plicated; transverse vessels all one size. Meshes square or slightly elongated transversely, with short blunt papillæ at the corners, and smaller intermediate ones on the internal longitudinal bars. Stigmata elongate-elliptical, rather short, four or five in a mesh.

Dorsal lamina strong, not very wide, transversely ribbed; margin provided with short teeth opposite the ends of the ribs and generally one or two smaller intermediate ones.

Tentacles simple, tapering, and slightly curved, numerous and closely placed, about 15 to 20 longer and stouter, between each pair of which are one or two small ones.

Olfactory tubercle simple, oval in outline, with the opening at the anterior slightly narrower end.

Viscera in a compact mass, occupying the posterior half of the left side of the branchial sac.

Locality. Attached to the under surfaces of large stones at extreme low water, near King's Cross Point, Lamlash Bay.

ASCIDIA PLEBEIA, *Alder.* (Plate XVIII. figs. 6–8; Plate XIX. figs. 1–4.)

Ascidia plebeia, *Alder, Ann. & Mag. Nat. Hist.* ser. 3, vol. xi. p. 155 (1863); *Alder, Hebrid. Invert., Brit. Assoc. Rep. for* 1866, p. 207 (1867); *Heller, Untersuch. ü. d. Tun. Adriat. u. Mittelm.* 1 Abth. p. 14, Taf. v. fig. 7 (1874).

This is a rather variable species, showing very different appearances according to its position and the objects to which it is attached; it also varies greatly in the amount to which it is covered by sand, shells, and other foreign bodies. Alder says "slightly covered with fragments of shell and sand at the attached end." Some of my specimens from Lamlash Bay have the soft dull-green test entirely exposed, while others are completely covered, even on the siphons in some cases, by a fine, but thick

coating of sand-grains, and in others by large pieces of shell, nullipore, and stones. Heller's figure is fairly characteristic; in many of my specimens, however, the atrial siphon is directed more posteriorly than dorsally, and is not so prominent.

I figure a specimen with the test removed (Pl. XIX. fig. 1), to show the elongated atrial siphon.

The characters of the internal organs are as follows:—

Branchial sac oblong, not longitudinally plicated, or only very slightly so. Transverse vessels stout, all the same size. Internal longitudinal bars conspicuous, bearing large papillæ at the angles of the meshes, and smaller, more conical intermediate ones; these latter are absent in a few of the meshes. Meshes slightly longer vertically than transversely, each containing three to five rather short stigmata.

Dorsal lamina transversely ribbed, margin minutely denticulated.

Tentacles inconspicuous, very slender, 72 in number, of three sizes arranged alternately—18 large, 18 medium-sized, and 36 small.

Olfactory tubercle oblong in outline, the opening at the anterior end of the right side; horns almost touching, not coiled.

This species comes near *Ascidia depressa*, Alder.

The condition of the olfactory tubercle described above (and figured on Pl. XVIII. fig. 7) is the one usually found; but in some specimens the horns are turned in (as shown on Pl. XVIII. fig. 6) but not coiled. In some parts of the dorsal lamina (see Pl. XIX. fig. 3) a series of papillæ is present, forming a line parallel to and resembling the denticulated margin.

Ascidia exigua, n. sp. (Plate XIX. figs. 5–8.)

External appearance.—Shape ovate-elliptical, anterior end slightly wider than posterior, both blunt and rounded; depressed, flattened laterally. Attached by the entire left side; margin slightly expanded here and there. Apertures both sessile, inconspicuous; branchial terminal, atrial about two fifths of the way down. Surface smooth. Colour yellowish grey. Length 1·1 centim., breadth 0·6 centim.

Test moderately thick, strong, transparent; no vessels visible.

Mantle well developed; muscular bands very delicate, but close, forming rather a fine network. Ocelli red, minute.

Branchial sac not longitudinally plicated, meshes having the

vertical extent greatest, with large conical papillæ at the corners and no intermediate ones. Stigmata oblong with rounded ends, usually two in a mesh.

Dorsal lamina ribbed transversely; margin irregularly pectinated.

Tentacles numerous, placed close together, about 20 large and the same number of rather small intermediate ones.

Olfactory tubercle irregularly U-shaped; opening anterior, wide.

Viscera rather small, seen distinctly through mantle on left side. Stomach large, yellow. Intestine narrow, black.

Locality. Lamlash Bay, 10 fathoms, Sept. 1879.

P.S.—In connection with the irregular branchial sac of *Ascidia scabra* (see Pl. XVII. fig. 3) mentioned on page 284, I have unfortunately omitted to refer to Lacaze-Duthiers' interesting description of three varieties in the branchial sac of *Ctenicella Lanceplaini* (Arch. Zool. expér. vol. vi. p. 619, 1877). But I hope to return to this subject in a future communication.

EXPLANATION OF THE PLATES.

Plate XIV.

Fig. 1. *Ascidia lata*, n. sp. Seen from the right side, natural size.
2. The same. Part of branchial sac, seen from inside, magnified.
3. The same. Olfactory tubercle, magnified.
4. *Ascidia fusiformis*, n. sp. Seen from the right side, natural size.
5. The same. Part of branchial sac, from the inside, magnified.
6. The same. Olfactory tubercle, magnified.

Plate XV.

Fig. 1. *Ascidia virginea*, O. F. Müller. Part of branchial sac, seen from inside, magnified.
2. The same. Part of branchial sac, seen from outside, magnified.
3. *Ascidia truncata*, n. sp. Seen from right side, natural size.
4. The same. Part of branchial sac, seen from inside, magnified.
5. The same. Olfactory tubercle and tentacles, magnified.
6. The same. Part of dorsal lamina, magnified.

Plate XVI.

Fig. 1. *Ascidia aspersa*, O. F. Müller. Part of branchial sac, seen from inside, magnified.
2. The same. Part of dorsal lamina, magnified.
3. The same. Olfactory tubercle and tentacles, magnified.
4. *Ascidia triangularis*, n. sp. Seen from right side, natural size.

Fig. 5. The same. Seen from left side, natural size.
6. The same. Part of branchial sac, from inside, magnified.
7. The same. Olfactory tubercle and tentacles, magnified.
8. *Ascidia scabra*, O. F. Müller. Part of branchial sac, from inside, magnified.

Plate XVII.

Fig. 1. *Ascidia scabra*, O. F. Müller. Olfactory tubercle, magnified.
2. The same. Part of circlet of tentacles, magnified.
3. The same. A very irregular part of branchial sac, from outside, magnified.
4. *Ascidia Patoni*, n. sp. Seen from the right side, natural size.
5. The same. Seen from ventral edge, natural size.
6. The same. Part of dorsal lamina, magnified.
7. The same. Part of branchial sac, from inside, magnified.

Plate XVIII.

Fig. 1. *Ascidia muricata*, Heller. Part of branchial sac, from outside, magnified.
2. The same. Olfactory tubercle and tentacles, magnified.
3. *Ascidia obliqua*, Alder. Part of branchial sac, from inside, magnified.
4. *Ascidia depressa*, Alder. Part of branchial sac, from inside, magnified.
5. The same. Olfactory tubercle and tentacles, magnified.
6. *Ascidia plebeia*, Alder. Olfactory tubercle, magnified.
7. The same. Another variety of olfactory tubercle, magnified.
8. The same. A third variety of olfactory tubercle, magnified.

Plate XIX.

Fig. 1. *Ascidia plebeia*, Alder. Specimen with test removed, from right side, natural size.
2. The same. Part of branchial sac, from inside, magnified.
3. The same. Part of dorsal lamina, magnified.
4. The same. Part of circlet of tentacles, magnified.
5. *Ascidia exigua*, n. sp. Seen from right side, natural size.
6. The same. A specimen with test removed, from left side, natural size.
7. The same. Part of branchial sac, from inside, magnified.
8. The same. Olfactory tubercle, magnified.

On the Land-Molluscan Genus *Durgella*, W. T. Blanford; with Notes on its Anatomy and Description of a new Species. By Lieut.-Colonel H. H. Godwin-Austen, F.R.S., F.L.S.

[Read December 16, 1880.]

(Plates XX. & XXI.)

The genus *Durgella* was founded by Mr. W. T. Blanford in February 1863, in a paper published in the 'Annals and Magazine of Natural History' *, which was really the first attempt to classify the Indian land-shells by the form of the animal; and in the section *Nanina* the form of the mucous pore at the extremity of the foot was principally relied on, together with the character of the shell. It placed several species in their correct natural divisions which were before unknown; and the localities are authentic, which renders the paper a valuable one as regards their distribution.

Durgella included three species:—

The type, *D. levicula*, Bens. Tenasserim (*Theobald*); Prome, in Pegu.

D. mucosa, W. & H. Blanf. Nilgiri Hills.

D. seposita, Bens. Darjiling. (Animal not seen by the author.)

The species *D. levicula* was described by Mr. W. H. Benson, in the 'Annals and Magazine of Natural History,' May 1859, p. 391, from a single specimen (which I take to be young) found at Phie-Thán, in Tenasserim, by Mr. W. Theobald. Benson's shells passed, some time after his death, to Mr. MacAndrew, and are now most of them in the Cambridge Museum and incorporated in the MacAndrew collection, and generally have "from Benson's collection" written on the new label, with India, Bengal, or Burmah as habitat; but I regretted to find Benson's original labels, in his unmistakable writing, have been destroyed, and with them all his valuable record of exact locality: this fault, however, does not rest, I am glad to say, on the Cambridge Museum. The original value of many of the species is gone for ever; and a good many have now no locality at all. There are two specimens of *D. levicula* in the collection from Tenasserim, one of which must be the type shell referred to. I have thus been enabled to compare and identify the specimens in my own collection; and I take this opportunity of thanking Mr. J. W. Clark, of Cambridge, for his courtesy in affording me every possible facility for examining this collection, which contains a very large number of type forms. The figure of

* "On Indian Species of Land-Shells belonging to the Genera *Helix*, Linn., and *Nanina*, Gray" (Ann. & Mag. Nat. Hist. ser. 3, 1863, vol. xi. p. 81).

D. levicula in the 'Conch. Indica,' pl. xc. figs. 1–4, is a fair representation of the shell, but over-coloured.

Mr. Ossian Limborg collected in spirit a very large number of *D. levicula* on the slopes of the Mulé-it range near Meetan, and a number also reached me alive in Calcutta which had been packed in a bamboo-tube. An examination of the animal shows that it is a very distinct genus, having but a distant relationship with *Girasia*, *Macrochlamys*, &c., and must be placed in a distinct group of its own. It will be interesting hereafter to see in which direction and to what extent its allied forms will be found to range, the extreme limits now being Assam on the N.W. and Tenasserim on the S.E.; for among a collection of land-shells, in spirit, most kindly got together by Mr. D. McTavish Lumsden at the tea-factory of Paniputer, near Tezpur, in Assam, during the last rainy season, were two specimens I at first sight thought belonged to *Macrochlamys*. On taking them up for examination, I found all the interesting characters again as exhibited in *D. levicula*; and I hope to be able to point these out in some degree of detail in the following notes.

I am very doubtful if *mucosa* can be placed in this genus: *seposita* may be, perhaps; but if, as Mr. G. Nevill thinks, *seposita* is the same as my *bilineata* from the Dafla Hills, then it must also be removed; for the latter is a true *Macrochlamys*.

It is not improbable that the large form *Helicarion præstans*, Gould, from Moulmein and other parts of Tenasserim, will find a place in or near this genus, judging from a figure of the animal which was made under the superintendence of Ferd. Stoliczka; and I wish I could obtain the species in spirit.

The Additional and Principal Characters of the Genus Durgella.

1. The right and left mantle-lobes moderate, the shell-lobes very ample; the right shell-lobe extends from the anal aperture (close to the upper angle of the shell-aperture) to the columellar margin, and spreads away over the shell in a broad triangular tongue; the left shell-lobe is reflected slightly over the edge of the shell in front, from near the respiratory orifice, and becomes wider on the lower margin as it approaches the umbilicus, and is also of triangular shape when extended. A large portion of the shell is always exposed.

2. The mucous pore is well developed, with a large overhanging lobe.

3. The jaw is very thin, membranaceous, almost straight on the margin, with a very slight central projection.

4. The odontophore is broader than long, with a central minute, tricuspid tooth; the lateral teeth all similar, minutely 6-cuspid or pectiniform, on a curved edge, very closely set together and exceedingly numerous. 170—1—170+.

5. In generative organs, an amatorial organ present in the Burmese form is absent in the Indian.

6. *Shell* thin or membranaceous, globose or depressedly conoid; polished, very closely perforate, the columellar margin having no solidity.

The abnormality of this genus, as compared with shells of similar form, lies principally in the very remarkable odontophore, which is quite unlike any other Indian species of the Zonitidæ that I have examined; with this, of course, we find the jaw also much modified. There is considerable similarity with the teeth of *Conulema attegia* and *C. infula* (figured by Stoliczka in the J. A. S. B. 1871, pl. xviii. figs. 4 & 9) in the multicuspid or pectiniform laterals and the greater number (153 on each side in *C. infula*); but the centre tooth is large and the shell-lobes of the mantle are not developed; still here we have relationship.

DURGELLA LEVICULA, Benson. (Plates XX. & XXI.)

Locality. Meetan, under the Mulé-it range, Tenasserim; very abundant (*O. Limborg*).

Shell very narrowly perforate, ovately globose. *Sculpture* smooth on last whorl, with regular shallow ribbing under a strong lens; the apical whorls are regularly and finely striate, crossed by oblique fine ribbing, and almost decussate. *Colour* when living pale greenish ochre, whitish towards the apex; with animal removed, very pale ochraceous. *Spire* low, convex. *Suture* rather shallow. *Whorls* $3\frac{1}{2}$ to 4, adpressed, well rounded (Plate XX. fig. 7). *Aperture* broadly ovate, oblique. *Peristome* thin; columellar margin rounded, slightly reflected, not at all solid.

Large specimen :—

Size—major diam. 0·35, minor diam. 0·30, alt. axis 0·18 inch.
„ „ 9·0, „ „ 7·2, „ „ 4·5 millims.

Diam. aperture 5·7, alt. aperture 5·0 millims. The ordinary size, however, is 7·0 millims., of the major diameter.

Living Animal.—Pale ochre, with a dusky line on the upper part of the extremity of the foot, also on the neck; tentacles moderately long; foot with mucous gland (Pl. XX. fig. 3 *a*), lobe over it moderate. A broad tongue-like expansion (figs. 3, 4, & 6, *r.s.l.*) on the right side of the aperture, another on the left margin of the

mantle (*l.s.l.*), which is reflected over the edge of the peristome. Left neck-lobe (*l.d.l.*) moderate. The length of an animal with a shell 0·4 in major diam. was 0·75 inch.

The foot below has a distinct central area, the perambulatory portion; the margin of the foot regularly segmented, both on the outside and viewed from below.

Generative Organs.—Neither the ovotestes, hermaphrodite duct, nor albumen-gland have I been able to make out in the spirit-specimens.

The spermatheca (Pl. XXI. fig. 1) is short, thick and wide at the base, with a narrow neck above, and a swollen rounded terminal portion (vide *Conulema*, Stoliczka). The amatory organ large, being twisted in form from its position in the spire of the shell; at the anterior end it terminates in a well-developed, pointed, cylindrical knob, which is the homologue of the dart, and which is contained in a large expanded muscular sac.

The penis has an expanded portion below the point where the retractor muscle is attached; and in one specimen this was developed into a cæcum-like process, which probably represents the "Kalksac" in other forms; there is another convolution near and below the junction of the vas deferens.

The odontophore (Pl. XXI. figs. 3, 3 *a*) is very broad, as described in the generic description; the central tooth is very minute, and so hidden by the larger laterals, that I have only been able to see it once. The lingual ribbon is extremely brittle, and generally parts upon the central line. It is very difficult to see the whole side of the odontophore at once and count the teeth; and I have not been able to count the number of rows, but they are considerably over a hundred. There must be at least 34,000 to 35,000 teeth. In *Conulema infula* Stoliczka records 30,000, in *C. attegia* 40,000: their extreme minuteness is shown by four medians occupying only 0·0005 inch; five laterals the same space. The jaw (Pl. XXI. fig. 5) is ·044 inch in length, very thin and membranaceous, nearly straight in front, with a very slight rise in the centre, convex above; muscular impressions striate from side to side, and arching sharply near the central portion; far less strongly formed than in *Macrochlamys* &c.

DURGELLA ASSAMICA, n. sp. (Plates XX. & XXI.)

Locality. Paniputer tea-garden, near Tezpur, Assam; only two specimens received (*Lumsden*).

Shell very thin and membranaceous, imperforate, depressedly conoid. *Sculpture* quite smooth, with some slight, indistinct, oblique shallow ribbing on the third whorl. *Colour* olive-brown.

Spire depressed. *Suture* impressed. *Whorls* 4, rather rapidly increasing (Pl. XX. fig 8). *Aperture* ovate, oblique. *Peristome* very thin ; columellar margin not at all thickened.

Size—Major diam. 0·38, minor diam. 0·33, alt. axis 0·17 inch.
„ „ 9·5, „ „ 8·2, „ 4·4 millims.

Animal.—The overhanging lobe to the mucous pore is largely developed. The lateral pallial line is distinctly marked by a double row of oblong segmental divisions or tubercles (Pl. XX. fig. 5, *s*, *s*); but the portion of the foot above it is smooth, with indistinct radiating irregular lines leading to the dorsal side (*s**).

In Pl. XX. fig. 6, I give the mantle-lobes detached from the body of the animal. They are as in *D. levicula*, only that the left dorsal lobe is divided into two distinct parts at about the middle of its length.

Generative Organs (Pl. XXI. fig. 2).—The albumen-gland is pear-shaped and well developed, with an expansion near the junction of the hermaphrodite duct. The oviduct is greatly swollen and enlarged, but, as usual, not well preserved. The spermatheca (*sp*) longer than in *D. levicula*, with the same swollen posterior termination and narrow median neck. The penis shows expanded portions in its course on both sides of the retractor muscle. *No amatorial organ* found in two specimens examined. Here we have a most interesting correspondence with what Stoliczka has recorded on the anatomy of *Conulema* (J. A. S. B. vol. xl. 1871, pp. 236–241, pl. xviii.), where he found it present in *C. attegia*, Bens., from Burmah, not so in *C. infula*, Bens., the Bengal or Indian form. This I take to be another proof of the close relationship of the genus *Durgella* and *Conulema* in the two areas; for we find that *D. assamica* bears exactly the same relationship to *C. infula* as *D. levicula* does in Burmah and Tenasserim to *C. attegia*—a modification from some older, earlier, and wider-distributed form having gone on in the two areas. But it would not, as Stoliczka says, be expedient, on this single point of structure alone, to place *attegia* and *infula* in different genera. On the contrary, it would be more in accordance with a strict classification to consider *Durgella* and *Conulema* as one, in spite of the very different and conchologically extreme form of their shells.

The odontophore (Pl. XXI. fig. 4) is as in *D. levicula*; the central tooth not seen. The jaw (Pl. XXI. fig. 6) very straight in front, thin, flatly convex above, rather narrow; the striate lines of muscular attachment form a broad arch over the central portion of the front edge.

List of Species of *Durgella*.

levicula, Bens.
assamica, Godw.-Aust.
seposita, Bens. ? Anatomy not examined.
mucosa, W. & H. Blanf. ? Anatomy not examined.
burmanica, Bens. ? Anatomy not examined. I have very little doubt about this shell, which I examined in the Benson collection.
shisha, Godw.-Aust. ? Anatomy not examined.

It would have been supposed, taking the shell-character alone, that *Helicarion Bensoni*, from the neighbourhood of Calcutta, would come into this list; but I have the lingual ribbon of this species from Mr. W. T. Blanford, and I find it similar to *Macrochlamys*. Similarly, taking the figures in Semper's 'Reis. Arch. Philipp.' pl. i. figs. 8 & 11, of *Helicarion bicarinatus* and *H. gutta*, the shells are very much like that of *D. levicula*; but they appear to have, besides the ordinary dentition, a different form of mucous pore and more complicate shell- and mantle-lobes. The same applies to *H. tigrinus* and *H. incertus*.

EXPLANATION OF THE PLATES.

Plate XX.

Figs. 1 & 2. Shell of *Durgella levicula*, Bens.
3. Animal (spirit-specimen): *r.s.l.*, right shell-lobe (the dotted line shows where it spreads over the shell when the animal is alive); *a.o.*, anal orifice; *r.o.*, respiratory orifice; *r.ap.*, renal aperture; *r.d.l.*, right dorsal lobe; *l.d.l.*, left dorsal lobe; *s*, lateral line; *p*, the central pedal area.
3 *a*. Extremity of foot; lobe above the mucous pore, as in life.
4. *l.s.l.*, left shell-lobe; *l.d.l.*, left dorsal lobe.
5. Portion of side of foot of *D. assamica*, much magnified: *s*, *s*, divisions of the lateral line; *s**, segmental lines running from it.
6. Diagrammatic view of the mantle-lobes of *D. assamica*: lettering as in fig. 3.
7. The sutural spiral of *D. levicula*.
8. The sutural spiral of *D. assamica*.

Plate XXI.

Fig. 1. Generative organs of *D. levicula*: *P.*, penis; *r.m.p.*, retractor muscle of penis; *am.o.*, amatory organ; *r.m.*, retractor muscle; *v.d.*, vas deferens; *sp.*, spermatheca; *ov.*, oviduct.
2. Generative organs of *D. assamica*: *h.d.*, hermaphrodite duct; *al.g.*, albumen-gland; *ov.*, oviduct; *sp.*, spermatheca; *v.d.*, vas deferens *P.*, penis; *r.m.p.*, retractor muscle of penis.
3, 3 *a*. Central laterals of *D. levicula*.
4, 4 *a*. Central laterals of *D. assamica*.
5. Jaw of *D. levicula*.
6. Jaw of *D. assamica*.

Observations on the Life-histories of *Gamasinæ*, with a view to assist in more exact Classification. By Albert D. Michael, F.L.S., F.R.M.S.

[Read February 3, 1881.]

(Plates XXII. & XXIII.)

My intention in this paper is to record the results of a series of observations, made during the year 1880, upon the life-histories of a few species of Gamasinæ, with the special object of endeavouring to decide some of the disputed points in reference to these creatures, which render any thing like knowledge of the family so difficult.

It will readily be understood how these difficulties arise on the very threshold, when the two gentlemen who have probably paid more attention to the subject than any one else living, viz. M. Mégnin of Versailles and Dr. Kramer of Schleusingen, are totally at variance upon such primary matters as whether certain conspicuous characteristics are fixed distinctions, affording a good basis for subgeneric and specific division, or whether they are simply marks of an immature stage, which will vanish upon attaining maturity.

During my late researches into the life-histories of another family of Acarina (the Oribatidæ), the results of which are recorded elsewhere*, I have become strongly impressed with the idea that detached observations, on captured specimens, are of secondary value, and that really reliable information upon the subject is only to be obtained by breeding the creatures in confinement, in vessels known not to contain any allied Acarina, and which will afford the means of very frequent observation of the individual specimens which are being traced. Great care and attention, however, is required to keep the creatures alive and healthy under these conditions. It is easy to breed numbers in large vessels containing quantities of shelter and food; but these are of comparatively little service, as the individual specimen is lost sight of.

It seemed to me that if some of the Gamasids could be bred through their lives, and watched in this manner, several of the questions above alluded to might be set at rest; but for a long

* Journal of the Royal Microscopical Society, vol. iii. p. 32.

time I was not as successful in rearing the Gamasinæ as I had been with the Oribatidæ. The former are far more active creatures, and did not thrive when confined in the small glass cells which I had used for the latter, and which are so handy for observations. I have at last succeeded in keeping the several species which I have attempted in good condition, and rearing them several generations, by using very large cells, and small round glass dissecting-troughs, each being covered by a flat plate of glass with two or three small holes in it, each hole being covered with very fine muslin gummed outside the glass, the cover being larger than the cell, and the holes in such a position that they can either be made to come over the interior of the cell so as to ventilate it, and allow the escape of moisture, or pushed beyond the cell-wall leaving the moisture confined. This arrangement, combined with a curtain, and, what is more important, care and frequent attention, enabled me to regulate the light, temperature, and hygrometric condition of the air in the cell, so as to obtain in each instance what was most suitable to my captives. They finally became apparently quite at home and contented in their prisons, not attempting to escape when the cell was sometimes uncovered for the use of higher powers: this is a great point, because habits cannot be observed when the creatures are excited and endeavouring to escape.

One very doubtful point had to be decided at the outset, viz. what the Gamasinæ really fed upon, as they manifestly could not be successfully reared unless supplied with proper food. Mégnin says* they are nourished on the liquid products of the decomposition of dead vegetables or the excrements of quadrupeds and birds; and he proceeds to cite the places where they are found as proof of this assertion. He is also decidedly of opinion† that the nymphs and females do not obtain any nourishment from the insects upon which they are so constantly found, but simply use them as a means of conveyance. Kramer also states‡ that damp and decaying vegetation are the necessaries of their existence. I did not find, however, that the Gamasids which I attempted to

* "Mémoire sur l'organisation et la distribution zoologique des Acariens de la famille des Gamasides," Robin's Journ. de l'Anatomie et de la Physiologie, May 1876, p. 325.

† *Loc. cit.* p. 290.

‡ "Zur Naturgeschichte einiger Gattungen aus der Familie der Gamasiden," Archiv für Naturgeschichte, 1876, erstes Heft, p. 47.

rear throve at all well when supplied only with decaying vegetation; and a comparison of their construction with that of other families of Acarina led me irresistibly to the conclusion that they were chiefly or entirely predatory. The remarkable power of darting each mandible separately with speed and accuracy of aim far in advance of the body, the powerful retractile muscles attached to these mandibles, the organization of the remainder of the mouth, the extreme swiftness of the creatures, the use of the front legs as tactile organs only, and not for the purposes of locomotion, and the ample supply of tactile hairs in front only all seemed to me to fit the animals for a predatory life, and to indicate habits similar to those of *Cheyletus* and *Trombidium* rather than of the true vegetable-feeders, such as the Oribatidæ, Tetranachi, &c. In this I was confirmed by frequently capturing Gamasids with small Thysanuridæ firmly held in their mandibles, a circumstance surprising enough, as one would hardly have expected that any development of the tactile sense would have enabled an eyeless being such as *Gamasus* to capture such active insects as *Podura* &c.; they are, however, certainly able to do so.

There are one or two remarks in the earlier writers which point in the direction of predatory habits. Thus Dugès*, speaking of the so-called *Gamasus coleoptratorum*, says:—In winter they are found under stones, and there doubtless live on other *Acari*; at all events, I have seen small Trombidies devoured by *Gamasus testudinarius*. Gervais also†, speaking of an unidentified species, says:—I have seen it seize a small Myriapod in its didactyle mandibles and run off rapidly with it. Led by these considerations, I determined to try feeding my Gamasids with cheese-mites. I first placed a single Gamasid in a cell and shook in some cheese-mites; the success was quite unmistakable. The instant that a cheese-mite touched one of the tactile hairs on the fore legs of the *Gamasus*, it was seized in the mandibles of the latter, drawn to the mouth, and sucked dry; the same took place with another and another, until the *Gamasus* was satiated. Since that time I have fed my Gamasids entirely upon cheese-mites with complete success; but they have sometimes varied their diet by eating one another. I am therefore of opinion that, at all events

* "Recherches sur l'ordre des Acariens." Troisième mémoire. Ann. des Sci. Nat. 1834, t. ii. p. 26.

† Walckenaer's 'Histoire naturelle des Insects, Aptères,' t. iii. p. 215.

as a rule, the Gamasinæ are predatory creatures, and that their being found in the situations before described is due to the fact that soft-bodied *Acari*, and minute soft-bodied insects &c., abound there, and afford ample prey.

While on this subject of the food, I wished, if possible, to ascertain whether the nymphs and females of Gamasinæ do really suck the juices of the insects upon which they are found, or only use them as a means of conveyance, as Mégnin contends. With this object, I placed a single Gamasid in a separate cell, and after a day or so ceased feeding it with a very sufficient supply of cheese-mites, but instead introduced some freshly killed dipterous insects, selecting those the juices of which would be dark or of strongly marked colour. The Gamasinæ, like many other of the Acarina, are sufficiently transparent to allow the colour of the food to show through the dorsal surface, looking like coloured markings; a circumstance which, not being understood by C. L. Koch*, induced that most laborious writer to create a great number of new species, dependent upon colour, which arose from the nature of the food the creature had been eating. I invariably found that for a day or so the *Gamasus* assumed the colour of the insect supplied to it. Thus after a black gnat had been put in, the markings on the *Gamasus* were black, after a scarlet *Trombidium* they were red; and I also observed that if the insect were at all large, the *Gamasus* seemed to prefer attacking the eye, and was then coloured for a day or so in accordance with the pigment-layer. It is therefore evident that the Gamasids do suck the juices of quite freshly killed insects; and although it is most difficult to watch them on the living insect, I cannot help thinking that they do obtain some amount of nourishment at the expense of their hosts during the period of their parasitism, or at all events that this is the case with some species.

Having now disposed of the question of food, I will relate the other observations which I was able to make; but before doing so, in order that the points I wished to elucidate may be understood, it is, I fear, necessary to show, very shortly, what other writers have done on the subject, and where the divergence of opinion principally exists.

Linnæus, who did not divide the *Acari* into families, found

* 'Deutschlands Crustaceen, Myriapoden und Arachniden' (Regensburg, 1839).

and named *Acarus coleoptratorum**, which is found abundantly parasitic upon Coleoptera, Hymenoptera, &c., and especially on the common *Geotrupes stercorarius*. The leading character of the species, or so-called species, is, that the dorsal surface is not covered by one chitinous plate, but by two separate ones, leaving a soft white space between them and round the hinder plate. (This is shown in Plate XXII. fig. 2.)

Geoffroy† followed Linnæus, calling the creature "mite des coléoptères;" and De Geer‡ also preserved it, calling it "*Acarus fucorum*." Schrank§, Hermann‖, Frisch¶, and others of the earlier writers also treat it as a well-established species. It was, however, Latreille** who instituted the genus *Gamasus*; and he made *coleoptratorum* the type of a new genus, *Carpais*, which genus he abandoned†† in his later works. The creature, from its abundance, came to be considered as a type of the Gamasinæ, which type has been followed by numerous writers down to the present time. Dr. Kramer in 1876‡‡ points out that more than one species has been included in the name "*Gamasus coleoptratorum*;" he defines them, and makes the separation of the two dorsal plates a ground for dividing the genus *Gamasus* into subgenera.

Other writers, such as Koch§§, have made the presence of a space between the two dorsal plates, or the visibility of the line of juncture, a means of classification.

Kramer's paper appeared in the first number of the 'Archiv für Naturgeschichte' for 1876; in May of the same year appeared Mégnin's paper above cited (in Robin's 'Journal de l'Anatomie' &c.). Mégnin utterly denies that *coleoptratorum* is a species at all. He says that the division of the plates on the back simply shows that the creature is in an immature stage, and is a nymph, or, rather, is constituted of the nymphs of at least three species, of

* Syst. Nat. 13th ed. p. 1026. no. 27.

† Hist. Ins. tom. ii. p. 623. no. 4.

‡ 'Mém. pour servir à l'hist. des Insectes' (Stockholm, 1778), tome vii. p. 112.

§ 'Obs. Hist. Nat.' tab. i. fig. 13.

‖ 'Mémoire aptérologique' (Strasbourg, 1804), p. 74.

¶ Ins. tom. iv. tab. 10.

** 'Précis des Car. gén. des Ins.' 1796.

†† Magas. Encyclop., *Gamasus*, &c.

‡‡ *Loc. cit.* p. 75.

§§ 'Uebersicht des Arachnidensystems,' 3tes Heft (Nürnberg, 1842).

which *Gamasus crassipes* is one; and he abandons the division of the dorsal plate as a means of classification.

In 1879 * Kramer replied, and affirmed that some of the adult Gamasinæ do show divisions between the dorsal plates, and adhered to it as a mode of distinction; he states that he has seen ripe eggs inside a species which he calls *G. nemorensis*, and which had divided plates on the back.

Linnæus † also named another well-known species, his *Acarus* (now *Gamasus*) *crassipes.* There has been a good deal of confusion with this species—Schrank and others having called allied species *crassipes* simply because they had the second pair of legs thickened, which is certainly only characteristic of the males, and is common to several species. Hermann, however, although his description is imperfect, gives figures ‡ which sufficiently identify the Linnean species. Hermann also gives a similar species, but without the thickened legs, which he calls *Acarus testudinarius*; and another, *A. marginatus*, the characteristic of which is showing a soft white line between the single chitinous dorsal plate and the ventral plate.

Mégnin asserts § :—First that the *Gamasus crassipes* of Dugès is the adult male of one of the three species of which *coleoptratorum* is the nymph; but as Dugès does not describe or figure the species, but simply refers to Hermann, this is equivalent to saying that *coleoptratorum* is the nymph of Hermann's *crassipes.* Secondly, that *testudinarius* is the female of *crassipes*; in this he is followed by Canestrini and Fanzago ‖. And, thirdly, that the characteristic of *marginatus* is simply that of the females of a large portion of the genus.

It was to assist in settling these various points and to learn what else I could of the life-histories of these creatures that I undertook the following observations, chiefly on *crassipes* and *coleoptratorum.* Whatever may be their value, they are, to the best of my ability, in every instance, faithful records of what I have actually seen take place with selected and known specimens in cages which I could place upon the stage of my microscope for frequent watching.

* "Ueber einige Unterschiede erwachsener und junger Gamasiden," Archiv für Naturgeschichte, 1879.

† Syst. Nat. ed. 12, sp. 8; Faun. Suec. 1769.

‡ *Loc. cit.* pl. 3. fig. 6, and pl. 9. Q, R.

§ *Loc. cit.* p. 330.

‖ "Intorno agli acari italiani," Atti del. R. Ist. Venet. di Sci. 1877–78.

Observations on Gamasus coleoptratorum.

First Generation.—On the 14th April, 1880, I captured, amongst some rubbish in my own garden, two Gamasinæ which, in my opinion, decidedly belonged to one of the species known as *coleoptratorum*, with the strongly divided dorsal plate, although they were not at the moment parasitic on the beetle. One is figured on Plate XXII. fig. 2.

By the 16th April they had become accustomed to the cell, and did not try to escape.

Up to 25th April they went on without any marked change, other than growing larger, the chitinous plates on the back not increasing in size, but the white margin becoming gradually broader.

On the 26th April I could not find them for a long time; at last I saw their front tactile legs waving about from beneath a dried seed-husk.

On the 27th, not seeing them, I turned the husk over and saw a cast skin; one soon ran out, it was larger, soft, and light coloured, and had evidently just cast the skin. A short time after the second emerged, which also had cast the skin. One, which turned out to be an adult male, was smaller than the other, and eventually became darker; this one is figured (Plate XXIII. fig. 1). Neither of these adults had any division whatever of the dorsal plate; they never became hard, but were of a more leathery texture; they were not Hermann's *crassipes*, nor had they any resemblance to it.

These two specimens were kept together; and on the 7th of May there were eggs in the cell, and the female continued to lay eggs; these eggs were placed in a separate cell.

19th May, the cell became too dry; the male was dead, but I revived the female with moisture.

Second Generation.—I cannot say when the first (six-footed) larva emerged from one of the above-named eggs: they are small and difficult to see; but they continued to hatch out until the 15th May. These larvæ were quite white and transparent, and did not show any sign of dorsal plates; they had a singular long hair in the centre of the posterior margin not found in the nymphs or adults. The larva is figured (Plate XXII. fig. 1).

In about three days the larva underwent the first change to the eight-footed asexual nymph; this also was quite white, and did not show any sign of dorsal plates.

After the first nymphal change of skin, the specimens showed the strongly divided dorsal plates, and were in every respect similar to the first pair when originally captured.

On 27th May the first adults appeared; they were of course precisely like those they were bred from, did not show any division of the dorsal plate, and never became hard and chitinous, but remained of a leathery texture.

Third Generation.—The adults bred on the 27th May again laid eggs, and I bred them through a third generation with similar results, which, therefore, I do not detail.

It now remained to show for certain that these actually were the same species as that parasitic upon the beetle; I therefore, on 18th July, 1880, captured a beetle (*Geotrupes stercorarius*) with a large number of *coleoptratorum* upon it. The closest examination did not show any difference between these and those bred before. I removed them from the beetle and established them in several cells. They throve just as well as those captured in the open, an interesting circumstance, because Dugès* says, with reference to them:—"It is to be noticed that almost all Gamasids dry up and die in a few hours after being separated from the insect or stone unless they are kept in a damp vase;" and Andrew Murray† repeats this as "a peculiarity of all these parasites on insects." The real fact is that they thrive on precisely the same treatment as those not captured on insects or under stones, and do not require as much moisture as many other non-parasitic Acari, as, for instance, some of the Oribatidæ, which never are parasitic in any stages. Probably Dugès did not supply them with proper food.

From the 1st to the 5th August most of those captured on the beetle became adult.

On 5th August I put an adult male and female of this lot into a small cell together.

On the 9th there was an egg in this cell, which I removed and put in a cell by itself.

On the 11th this egg hatched, and produced a hexapod larva.

On the 14th this larva changed into the nymphal stage.

On the 19th it underwent ecdysis and became a mature nymph;

* *Loc. cit.* p. 26.

† 'Economic Entomology,' p. 158.

it subsequently became adult, but I am not certain of the day of the change.

I had other eggs which were laid by the same pair of Gamasids, and which I bred through all the changes with a merely confirmatory result.

There were, however, two or three of the nymphs, originally captured on the beetle, which, although they attained the mature nymphal stage, never seemed to get any further. I kept them alive for about three months; they then died without becoming adult.

In all stages the specimens captured on the beetle were precisely like those captured in the open.

A microscopical examination of the cast nymphal skins of this species shows that the dorsal plates are composed of cells, the form and arrangement of which is delineated in Plate XXIII. fig. 8, and which exhibit but little granulation. It will be seen that the cellulation is very different from that of *crassipes* shown in Plate XXIII. fig. 7; but the cellulation of the ventral plates in the *coleoptratorum* nymph is very similar to that of the dorsal surface of *crassipes*.

Observations on Gamasus crassipes.

On the 14th April, 1880, two females and one male of this species were put in a cell by themselves.

On the 21st I noticed eggs in the cell; one of the females seemed to keep possession of a sort of retreat in the moss which had several eggs attached to it.

The egg is an oval with very blunt rounded ends, the surface slightly roughened by irregular depressed lines; it is white, very opaque, and always attached by a few threads to the substance it is deposited on.

The major axis is about ·4 millim.
The width at the larger end about ·28 millim.
„ „ smaller „ ·24 millim.

On the 23rd the first hexapod larva emerged. I put it in a cell by itself with one of the eggs. This larva is drawn in Plate XXII. fig. 3. Like all larvæ of Gamasinæ, it is white and semitransparent.

On the 26th the larva changed to the nymphal state.

This nymph was quite white at first, but gradually became larger and a little darker.

On the 2nd of May the nymph changed its skin. The cast skin did not show any trace of plates, and was quite white, except that there were a few chitinous dots or cells scattered about it, each having a darker nucleus. A few of these cells had approached certain others in little groups, where they had begun to assume a hexagonal or pentagonal form: these cells could not be distinguished on the living creature, but only by examining the cast skin.

The nymph, after the change of skin, did not then show any trace of detached dorsal plates. It continued to get larger and darker up to 15th May, but still did not show dorsal plates.

On 15th May the nymph again changed its skin, and became a perfect male; it was, as usual, rather light at first, but gradually acquired the full hardness and darkness of the adult species, which is wholly dark and chitinous.

Although the nymph up to the last did not exhibit any dorsal plate, yet on examining the cast skin two dorsal plates were clearly visible with a space between them; they were, however, so much lighter and thinner than in *Gamasus coleoptratorum*, that when on the creature they could not be distinguished as plates at all, but only as a slight darkening of the surface. The cellulation was quite different from that of the dorsal plates of *G. coleoptratorum*, being composed of more equal-sided hexagonal or pentagonal cells irregularly placed, and each cell appearing to be formed of smaller granules.

I bred several other specimens, the times being nearly identical from the hatching of the eggs. All the eggs first laid, and which I knew, because I removed them and placed them in separate cells, turned out to be males, all the later laid eggs turned out females. The times occupied by the changes from hatching to attaining the adult form were about the same in the females as the males, and there was the same apparent absence of dorsal plates.

I did not get any perfect females until about a month after the first males had emerged; but of course it is highly probable that, under natural conditions, more eggs might have hatched and a larger proportion been reared; and thus the females might have followed more closely on the males.

These females had the single dorsal plate detached from the sternal plate, and showing the white membranous line between,

which was taken by the earlier writers as the characteristic of the so-called species *G. marginatus*; this line was so narrow at first, that it could scarcely be seen; but as the eggs ripened in the ovary, the abdomen became distended and the line became gradually broader, particularly near the posterior margin, where the large ripe egg (for one only is usually ripe at a time) generally lies.

I bred from these males and females, and traced them through a second generation with similar results.

A point which struck me as singular, and contrary to what has been believed, was the absence of any inert stage before the changes of skin, or from one stage to another. In the Oribatidæ and other Acarina which I have previously watched, each change is preceded by a period of such absolute quiescence that any person not acquainted with the creature would suppose it to be dead; not a sign of life is to be obtained by touching it or otherwise. Mégnin, following Claparède's observations, is of opinion that during this period the whole internal parts dissolve and reform; and he expressly says that this is the case with the Gamasinæ*. I am not able to agree with him in this; for certainly in no specimen which I have bred have I been able to observe any inert period; the creature has only become rather less active for a few hours; and among the thousands of Gamasids which I have had from time to time I never noticed an inert specimen, although one is constantly finding inert Oribatidæ.

Another somewhat important matter in which I do not find myself able to arrive at the same conclusion as Mégnin is the period of copulation. Mégnin was, I believe, the first to point out that in the Dermaleichi (*Analges*) the adult male copulates, not with the finally adult female, which possesses the strongly marked external vulva, but with the female in an earlier stage, which he calls nubile female (femelle accouplée), at which period it closely resembles the nymph, and does not possess any external vulva. Mégnin points out that copulation takes place by the anus; and there cannot, I think, be any doubt that, with regard to the Dermaleichi, he is right in both respects, subject to the possible dispute as to whether his nubile female is actually distinct from the nymph; he gives very good reasons for thinking that it is. Mégnin, however, does not stop here; he distinctly asserts in his subsequent writings that these two points hold good,

* *Loc. cit.* p. 323.

not only with the Dermaleichi, but also with all other families of Acarina; and in his treatise on the Gamasinæ before quoted he says (at p. 322):—"Copulation in the Gamasinæ, as in all Acarina which we have observed, does not take place by the vulva of oviposition, which does not exist at the time of copulation, but by the anus. It is not the large, adult, egg-bearing female which receives the male, but the young female, still bearing the appearance of a nymph, and not presenting any trace of sexual organs. It is only *after* fecundation, and after a final change of skin, that the oviscapte, or vulva of deposition, appears."

I have elsewhere given my reasons for being decidedly of opinion that in the genus *Glyciphagus*, at all events, copulation takes place with the adult female; and I have now to add that the result of my observations on the Gamasinæ leads me to the conclusion that in those species which I have bred copulation has taken place with the adult female, and not with the female in any immature stage; and, in my opinion, Mégnin is not correct in saying that in the Gamasinæ it takes place by the anus.

I was desirous of seeing how the copulation took place, and particularly how the enlarged second pair of legs of the male in such species as *crassipes* were used. When my captives got accustomed to the cells, I had several opportunities of watching it. The adult male rushed up to the adult female (never, in any instance that I saw, to an immature one), approaching her from behind; on reaching her, he turned suddenly over on his back and slipped underneath the female, seized one of her hind legs with each of his enlarged legs of the second pair, which was doubled back upon itself. The leg of the female was clasped between the great apophysis on the second joint of the enlarged leg of the male, which curves forward and upward, and the smaller one on the fourth joint, which in this position of the leg curves backward and downward; this arrangement brings the genital aperture of the male immediately below the vulva of the female, which is placed further back than the male organ. The two are so firmly locked, that they may sometimes be rolled over and examined without separating.

Conclusions.

The principal results of my observations may, in my opinion, be shortly summarized as follows:—

1. That Mégnin is correct in saying that *Gamasus coleoptraorum*, and other allied creatures with the conspicuously divided

dorsal plates, are not species at all, but are immature stages of other species.

2. That the division of the dorsal plate is, in most cases at all events, a question of degree, and does not form a sound basis for classification, as applied by Koch, Kramer, and others.

3. That the dorsal plates do not grow gradually, but alter in size, shape, or development at the ecdysis.

4. That Mégnin is right in saying that the characteristic of the so-called *G. marginatus* is simply a provision possessed by the females of a large number of species.

5. That the extent of the white margin depends upon the extent to which the abdomen is distended by eggs.

6. That Mégnin is in error in saying that *coleoptratorum* is the nymph of *crassipes*. The nymph of *crassipes* does not show any divided dorsal plates which can be seen on the living creature.

7. That in the species which I have bred there is not any inert stage before the transformations or ecdyses.

8. That in the same species copulation takes place with the adult female, and not with the immature one as Mégnin contends, and that it is by the vulva, not the anus.

EXPLANATION OF THE PLATES.

Plate XXII.

Fig. 1. Larva of *Gamasus coleoptratorum*, × about 35.
2. Nymph of *Gamasus coleoptratorum*, × about 35. It is from this nymph that the so-called species was named.
3. Larva of *Gamasus crassipes*, × about 35.

Plate XXIII.

Fig. 1. Adult male *Gamasus coleoptratorum*, × about 35.
2. Caruncle and claws of same.
3. Side view of mandible of adult female of same, × 55, rendered transparent so as to show the articulation of the movable joint, the thickness of the chitine, &c.
4. Organ (*qy.* tactile ?) depending from epistome of *Gamasus crassipes*.
5. Scattered nucleated chitinous cells on the first nymphal cast skin of *Gamasus crassipes*.
6. Next stage. Cells aggregating into groups, but still preserving a somewhat rounded outline.
7. Later stage. Cellulation of semitransparent dorsal shield, visible only on the cast nymphal skin: *Gamasus crassipes*.
8. Cellulation of conspicuous dorsal shield of nymph of *Gamasus coleoptratorum*.

Observations on some British Fishes.

By Francis Day, F.L.S.

[Read February 17, 1881.]

During the last twelve months I have collected a few facts relative to some reputed British fishes which would seem to show that the usually admitted forms may be still further reduced in number. The first species I wish to allude to is one which was obtained by a most indefatigable zoologist, Mr. Cornish, of Penzance, who has procured so many rarities from the seas of Cornwall.

Pammelas perciformis, *Mitchill.*

Rudder-fish or Perch Coryphene, *Mitchill, Lit. & Phil. Soc. New York*, i. pl. xvi. f. 7 (no description). Coryphæna perciformis, *Mitchill, Amer. Month. Mag.* ii. p. 244. Trachinotus argenteus, *Storer, Mass. Report*, p. 55 (not *Cuv. & Val.*). Palinurus perciformis, *De Kay, New York Fauna, Fishes*, p. 118, pl. xxiv. f. 25. Pammelas perciformis, *Günther, Catal.* ii. p. 485. Palinurichthys perciformis, *Gill, Amer. Fish. Report*, 1873, p. 804. Pimelepterus cornubiensis, *T. Cornish, Zoologist* (2), ix. 1874, p. 4255.

Mr. Cornish has so fully described the specimen, which was $14\frac{3}{4}$ inches long, that further remarks appear to be unnecessary. The fish is stuffed, and in the collection of Sir John St. Aubyn, by whose permission Mr. Cornish kindly had a photograph taken* and sent to me. The history of the capture is so remarkable that I cannot resist transcribing it, as it may be open to discussion, how did the fish first get into the box? where did this take place? how did it arrive alive and well off Cornwall?

On October 9th, 1874, this fish was taken about six miles off shore by the crew of a Penzance trawler, who discovered it floating as a waif on the ocean in a wooden box or case, the four sides and bottom of which were perfect, but one board was torn off out of the four which had originally formed the lid. The captive fish was in a good state of health.

In examining Yarrell's and Couch's Histories of British Fishes the number of discrepancies among the Tunnies is remarkable.

* Photograph exhibited at the Meeting.

Orcynus (or *Thynnus*) *brachypterus* is unquestionably the immature of *O. thynnus*, the Common Tunny.

Yarrell, edition 2, vol. i. p. 160, has a figure of *Auxis vulgaris*; the same woodcut reappears in edition 3, vol. ii. as *Thynnus brachypterus*, with which species it is not related. In the second edition, as a vignette, at p. 159, is shown a *Pelamys sarda*, having only transverse bands; in the next edition the same figure appears as *Auxis vulgaris*, while a new figure of *Pelamys sarda* is added, showing only the oblique, and not the transverse bands.

Couch equally is in error respecting his figures of these fish, as in volume ii. p. 102, plate lxxxv., we find the pelamid *Pelamys sarda* showing merely oblique, but not transverse, bands; while in volume iv. p. 425, plate lxxxii.*, is the same species figured, showing transverse, but not oblique, bands, and named "Short-finned Tunny," *Thynnus brachypterus*. Consequently it does not appear that Couch ever received an example of the true *Thynnus brachypterus*, all the fish thus named by him being specimens of *Pelamys sarda*.

For the next few species I am chiefly indebted to Mr. Carrington, F.L.S., Naturalist to the Royal Westminster Aquarium. Some were obtained in the Channel Islands by his assistant Mr. Edward Matthews, others by Dr. Murie and Mr. George Brook, F.L.S., to all of which gentlemen my thanks are due.

Liparis Montagui, *Donovan*.

Some very fine examples, up to 3·6 inches in length, were taken at the mouth of the Thames. The largest had D. 30, A. 24, and a very distinct membrane connecting the last ray of the dorsal and anal fins with the upper and lower edges of the caudal, while the pectoral was deeply notched. Ventral disk oval, not quite half as long as the head. The greatest depth of the body thrice and one fourth in the entire length of the fish, and the length of the head slightly less. The teeth rasp-like. *Colours* of a dull grey, covered with small black spots, which on the fins, especially the caudal, become almost bands.

Lepadogaster Decandolii, *Risso*.

A beautiful example, 3 inches in length, was taken from under a stone in a rock-pool at low-water at Jersey by Mr. Matthews, while searching for crabs. Of a beautiful red colour, its head

and body were covered with oval light spots, some of which were also seen on its dark dorsal fin. The large round black spot, surrounded by a light ring, on the cheek and the band on to the opercle were well marked. Lips very thick.

LABRUS MACULATUS, *Bloch*, var. DONOVANI.

? Comber, *Jago, in Ray's Synopsis Pisc.* p. 163, fig. 5. Comber, *Pennant, Brit. Zool.* ed. i. 1776, iii. p. 252, pl. xlviii. fig. 122, and ed. ii. 1812, iii. p. 342, pl. lviii. Labrus lineatus, *Donovan, Brit. Fishes*, iv. pl. lxxiv; *Turton*, p. 99; *Fleming*, p. 209; *Jenyns*, p. 209; *Yarrell*, ed. i., i. p. 315, c. fig. Labrus cornubiensis, *Couch, Trans. Linn. Soc.* xiv. pt. 1, p. 80. Labrus Donovani, *Cuv. & Val.* xiii. p. 39; *Yarrell*, ed. ii., i. p. 315, c. fig.; *Günther, Cat.* iv. p. 71; *Steindachner, Ich. Span. u. Port.* 1868, p. 25, t. iv. fig. 2. Labrus comber, *Yarrell, Brit. Fish.* ed. i., vol. i. p. 289, c. fig., also in ed. ii. & iii. Green Wrasse, *Couch, Fish. Brit. Isles*, iii. p. 30, pl. cxxvi. f. 1, and Comber Wrasse, iii. p. 32, pl. cxxvi. f. 2.

The varieties of *Labrus maculatus* to which my remarks will be almost confined are those that have been included under the terms of the *Green Wrasse* of Donovan and the *Comber Wrasse* of Pennant. They are very easily distinguished by their respective colours; but, as pointed out by Thompson in 1837 (P. Z. S.), the tints of the *Ballan Wrasse* are prone to assume so many changes, that he proposed to term it *Labrus variabilis*, under which he included *L. lineatus*, or the Green Wrasse of Donovan.

Valenciennes first drew attention to the Green and Comber Wrasses being probably identical, and suggested that such might eventually turn out varieties of the *Labrus bergylta*, the *L. maculatus* of Bloch. Yarrell and Couch, however, continued to consider the *Green* and the *Comber* both as distinct species, and different from the *Bergylt* or *Ballan*. Thompson, as I have stated, considered the *L. lineatus* as a variety of *L. maculatus*, but omitted any reference to the *Comber* Wrasse; while White placed all these forms under that of *Labrus bergylta*, but without stating his reasons for doing so. Günther located the Green Wrasse, *L. lineatus*, Donovan, as a synonym of *L. maculatus*, Bloch, but gave *L. Donovani*, Cuv. & Val., as a separate species, on which very probably *L. comber* of Pennant has been founded. Steindachner has described and figured *L. Donovani*, Cuv. & Val., the adult of the *Comber* of Pennant and others. This brings us to consider whether the *Green* and the *Comber* Wrasses are distinct species,

and also if they are, or are not, varieties of the *Ballan* or *Bergylt* Wrasse.

Among the fishes which I received from Mr. Carrington, captured by Mr. Matthews from crab-pots at Jersey, I found eight examples of the *Green Wrasse*, or *Labrus lineatus* of Donovan. The length of these specimens and the number of spines and rays in their dorsal fins were as follows:—Length 2 to 4 inches; two had D. 21/11, two D. 21/10, three D. 20/11, and one D. 20/10; while a very fine example, 16 inches long, from Brixham in the autumn of 1880, had D. 21/9. Thus one had 32 spines and rays, six had 31, and two had 30.

The first thing that attracts one's notice in the eight small specimens referred to is that the height of the dorsal spines equals or nearly so that of the rays. If we examine the adult example, we perceive the soft portion of the fin much higher than the spinous, a similarity to what also obtains in a Ballan Wrasse of the same size. Secondly, in all of these eight immature examples there existed a dark spot at the base of the last one or two dorsal rays. The number of spines and rays are not constant: thus, out of nine examples they numbered from 30 to 32, the spines varied between 20 and 21, and rays between 9 and 11. In short the teeth become less prominent with age, the lips larger, the eye smaller, and the spines of the dorsal fin of less height than the soft rays, while the caudal becomes more obtuse, and a single row of scales accompanies each ray.

These changes are not restricted to this one form, the *Labrus lineatus*, Donovan, or *L. Donovani*, Cuv. & Val., as the same occurs in other varieties of the same species; and among the examples given me by Mr. Carrington from Jersey was a beautiful specimen of the *Labrus comber* of Pennant, or Couch's and Yarrell's *Comber Wrasse*. This fish would appear to be somewhat rare, and seems to have been first alluded to by Jago; but his figure and description are too vague to enable one to be sure. It is certainly identical with Pennant's *Comber*, while his figure is from an immature example, as is also Couch's, as may be recognized by the spinous dorsal being as high as the rayed portion, as I have remarked occurs in the Green Wrasse. Steindachner has given a beautiful figure, which he also refers to *Labrus Donovani*; it is a little over $9\frac{1}{4}$ inches long, and the dorsal fin shows the same change as in the Green Wrasse, the spines being of less height than the rays, the example, in fact, approaching the adult stage.

Not only do we see changes of form in this fish occurring with age, but the vividness of the colours also diminishes. In Cuvier and Valenciennes it is observed that the back and fins of *Labrus Donovani* are green, the under surface of the throat yellowish, abdomen olivaceous. A longitudinal silvery streak divides the darker back from the pale sides, and some white bands exist on the head and abdomen. Couch found in *Labrus comber* the ground-colour of a rich, deep mahogany-red, with pale streaks on the head and a wide white band along the body; abdomen reddish, tail with six broad transparent patches irregularly arranged, and dots of very dark brown at the base of the rays. He tells us that "a few hours after death these spots generally vanished, and the colours became uniform." In Steindachner's example the white lateral band is seen, but those upon the head have vanished.

The true *Comber* Wrasse may be defined as invariably possessing a white lateral band along the body from the eye to the centre of the base of the caudal fin. My Jersey specimen is immature, as demonstrated by its fins, while its entire length is $5\frac{1}{4}$ inches. Its colours were very beautiful when I first saw it, although it had been some time out of the sea. The back was red, separated by a white lateral band from an olive dashed-with-red abdomen. Some irregular dark bands went from the back down the sides, while the lower half of the body had numerous light spots. A white dark-edged band passed from the snout through the centre of the eye, terminating in the white lateral body-band. A second band crossed from the angle of the mouth below the eye on to the opercle, while a lighter one existed along the subopercle. The spinous portion of the dorsal fin had dull reticulations; an oblique and broad light band crossed the soft dorsal, which was also spotted, and had a dark mark at the base of the last five rays. Three black dots at the base of the pectoral fin; anal with a dark spot at the root of the third spine and a light ocellus on the base of the central rays; caudal with some black spots, giving the appearance as if the fin had been reticulated.

The *Comber Wrasse* may be red or green, but with a light lateral body-band, those on the head being present or absent. Its fin-rays, scales, and proportions are identical with what obtains in the *Ballan Wrasse*, *Labrus maculatus*, with which it must in future be included as one of its many variations in colour.

CRENILABRUS MELOPS, *Linn.*

Crenilabrus Baillonii, *Couch, Fish. of the Brit. Isles,* iii. p. 45, pl. cxxxii.

I have no hesitation in uniting these two forms as figured by Couch. I received from Mr. Carrington, nearly two years since, a beautiful example of *C. melops*, var. *Donovani*, Cuv. & Val., coloured as shown in my figure*. The specimen kept in spirit has now lost nearly all its markings and become, on a casual inspection, quite similar to Couch's figure. If the latter is examined, it will be seen that it has five rows of scales across the cheek, and a dark mark behind the eye, as seen in *C. melops*, whereas *C. Baillonii*, Cuv. & Val., has only two or three rows of scales across the cheek and no dark spot behind the eye. Couch, in introducing this fish to the British Fauna†, observes that he does so "with some degree of hesitation; but a drawing of one which came a few years since into my possession, and which then appeared to differ from the ordinary appearance of the Corkwing," conveyed so near a likeness to Dr. Günther's description of *Baillon's Wrasse*, that he inserted it. Identifications of Wrasses simply from coloured sketches is at all times a dangerous plan; but when it becomes a question of two so nearly allied, it is hardly justifiable. However, my kept specimen would be similar to a fresh one some time from its native element; and shows the conclusion of Couch is inadmissible, his fish being *C. melops*, Cuv. & Val.

On February 11th I received from Brixham two exceedingly interesting examples of Pleuronectoids coloured on both sides of the body, the one being a *Brill*, the other a *Common Sole*. The remarkable phenomenon existed in both, that the eyes had gone completely over in a perfectly regular manner to what should have been the upper surface; and, as will be seen in the coloured drawings [exhibited], the dorsal fin is likewise in its normal position in each specimen, or passing forwards anterior to either eye, completely dividing the two sides of the head.

RHOMBUS LÆVIS.

This example of the Brill is $21\frac{1}{2}$ inches in length; D. 81, A. 56.

* Drawing exhibited at the Meeting.

† In Catal. Fish. Brit. Museum, 1862, iv. p. 84, "British Channel" is given as one locality of its habitat, but its capture there is not otherwise referred to.

Eyes in the normal position. The whole of the under surface of the body, except the head, coloured similarly to the upper surface.

Solea vulgaris.

Length $11\frac{1}{2}$ inches; D. 76, A. 67. Eyes in the normal position. The whole of the under surface of the body except the head coloured as on the upper surface.

These two specimens afford proof that the position of the upper eye is not necessarily correlated to the colour which exists upon, or is absent from, the under surface of the fish. In most of the double examples, or those coloured on both sides, which I have previously obtained, doubtless the upper eye has had its progress arrested when in course of passing over to the opposite side of the head—apparently confirmatory of the theory which has been advanced, that the under surface becomes etiolated, due to the loss of influence of the organ of vision over its pigment-cells; and that in double examples the colour is due to the eye not having been completely transferred, and still retaining its power. Other theories have been advanced, but it would seem by no means unworthy of consideration whether these double flat fishes are not retrogressions towards what existed in an earlier stage of development.

Pleuronectes flesus.

This example, from the Westminster Aquarium, is 3 inches long; D. 61, A. 41. Eyes normal; anterior half of body dark; posterior half white blotched with brown; caudal fin mostly grey; some blotches on dorsal and anal fins; under surface of the body white. Here the eyes were normal on the usual side, yet the posterior half of the body was white blotched with darker. Some authors have considered these more or less albinos, or as sports due to crossing.

Ostracion quadricornis, *Linn.*

Couch, in the 'Intellectual Observer,' v. p. 407, remarks that one of these fish, residents of the tropical parts of the Atlantic Ocean, had been taken in Cornwall in a net at some rather considerable distance from land; and in his 'Fishes of the British Isles' it is figured at pl. ccxlii., leaving no doubt as to the species alluded to.

Couch laid claim to this fish having been discovered as a rare visitor to our shores, informing his readers that the authority was R. Lakes, Esq., of St. Austel's, from whom he received the specimen, "with the assurance that it had been obtained from a fisherman of Mevagissey, on the south coast of Cornwall, and that this man affirmed he had taken it in a net at some rather considerable distance from land." On inquiry this fisherman asserted "that a fish exactly similar had been taken about two years before by a fisherman of the same place; and another was viewed at leisure, and particularly described to myself, but not taken, by an ordinary observer, who watched it in shallow water further east on the same coast."

Having received an invitation to Mevagissey in order to see the Pilchard-fishing in August 1880, I gladly availed myself of the opportunity, and among other subjects inquired about the amount of credit to be attached to this fish as a British specimen. It appeared that the example had been parted with to Mr. Lakes by a sailor, who was also a fisherman, named Matthew Barron, and that he had been mate of a vessel, 'The Roseland,' which at the time inquiries were first being instituted happened to be lying in St. Austel's Bay. The master, on being shown Couch's figure of the fish, at once expressed his opinion that his mate had brought the example to England in salt, and which he remembered supplying to him for the purpose of preserving it in. Barron on being spoken to declined any information, except that it came from a long way off land. Subsequently the figure from Couch was taken round to the various fishermen in Mevagissey, one and all of whom denied ever having seen such a fish captured at that port, although most of them had seen such a one brought by Barron from "foreign parts."

My informant sent Mr. Couch the foregoing information, and I was shown his letter received in reply. Mr. Couch observed, on March 2nd, 1868, "After all such a fish may have wandered to our coasts is not beyond the bounds of belief, although its native country is far away; but the fact of a doubt among your neighbours throws some suspicion on what had been reported to Mr. Lakes."

That this fish may wander to our shores is perhaps hardly more improbable than the advent of *Pammelas perciformis*; still the fact that Couch's specimen had been captured at Mevagissey is as unreliable as that of *Holocanthus tricolor*, reported last

year to have been taken on the island of Lewes, but which on investigation turned out to have been similarly brought from its native habitat*.

CLUPEA SPRATTUS.

Although Mr. Holdsworth, in his excellent work on 'Deep-Sea Fisheries' (pp. 133, 134), has alluded to the subject of the spawning of these fishes, I have thought that further confirmation of his observations might be desirable. I have therefore this season had examples collected and sent to me from Cornwall, when on January 12th I found some had fully developed ova and others similarly forward milt.

On the Apparent Retention of a Sur-anal Plate by a young *Echinometra.* By F. JEFFREY BELL, M.A. (Communicated by Dr. J. MURIE, F.L.S.)

[Read March 3, 1881.]

IT will, I think, be of interest to direct the attention of the Society to the characters of the apical system of a small specimen of what I take to be an example of the species *Echinometra viridis.* Did it stand alone, we might have some difficulty in associating it with any completely adult form as yet known to us; fortunately, however, there are in the National collection three other specimens, which exhibit a less remarkable arrangement of the parts of their apical area: none, unfortunately, have any definite history, and they are all denuded of spines.

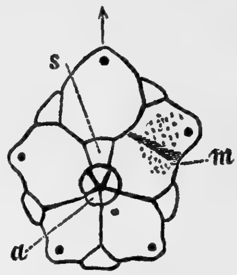
The retention of a sur-anal plate in a test with its longest (though not its morphological) axis as much as 12·5 millim. long is a point of sufficient importance, in so differentiated a genus as *Echinometra,* as to make the determination of the species a matter of comparatively secondary concern.

That the plate in question is to be regarded as a persistent sur-anal will be seen to be something more than a plausible suggestion, if the illustrating woodcut be carefully examined. In character and relation it would correspond either to the definition

* Since reading this paper I have received a note from Mr. Dunn, of Mevagissey, who informs me that he has just seen Captain Ball, of 'The Roseland,' who has informed him that Barron brought the Ostracion in question from the Island of Ascension.

of Wright, "additional or sur-anal plate developed in the centre of the disk before the anal opening;" or, in the words of the more recent definition of Alex. Agassiz *, it has "an ocular plate opposed to the median line of the subanal plate, the adjoining genital plates uniting just in front of this imaginary median line to separate the ocular plate more or less from the anal system."

There are other points in the characters of the constituent plates of the apical area that are worth a moment's attention: the large size of the genital plates, the small extent to which that which bears the madreporite is perforated, the presence of five valve-like anal plates, are indeed suggestive points.



Sketch of parts of young *Echinometra*, enlarged 4 times, and showing, *s*, sur-anal place, *a*, anal plates, and, *m*, madreporic plate.

But it only remains to be noticed that we have here to do rather with a case of reversion than of direct inheritance; the three other specimens, which clearly enough belong to the same species, have none of them any persistent plate. Of the three, unfortunately only one has its anal plates preserved, and it has but three. On the other hand, if it be a case of reversion, the ancestor of the *Echinometra* had no slight resemblance to *Salenia*; and the fact will have to be borne in mind when a serious attempt is made to define the relations of the Salenidæ to the rest of the regular Echinoidea.

The difference between this sur-anal plate and the large plate on the anal area proper, which is not unfrequently found in specimens of *Temnopleurus* and other forms, seems to me to suggest the question whether the sur-anal plate has really, of itself or primarily, any relations to the covering plates of the anal area. In the specimen here figured it has, at any rate, no share in covering that orifice. Notwithstanding its retention, proper anal plates have become developed, and alone exhibit relations to the anal orifice. Here, just as in *Salenia*, there is no question as to the small anal plates being distinct from the sur-anal. In *Temnopleurus* and its allies the large plate lies *within* the boundary of the anus, and may even not quite touch the periphery of the anal area. So far, then, as morphological identity can be spoken to by similarity in position, the homology which has of late been generally regarded as subsisting between these plates must be some-

* Bull. M. C. Z. vol. ix. p. 187.

thing more than doubtful. The absence of such an anal plate in the ancient Cidaridæ, the mode by which the anal plates appear in *Echinocidaris*, the membranous condition which obtains in *Diadema* (a form ancient enough, as we now know, to retain a rudimentary internal gill), suggest that what is seen in the more highly differentiated Temnopleuridæ is due to some secondary process now considerably obscured. It is possible that an increase in the rapidity of the rate of development has here, as sometimes happens with the blastopore and the mouth or anus, given to a more lately acquired structure a superficial resemblance to one which was not even its proper predecessor.

On a Lithistid Sponge and on a Form of *Aphrocallistes* from the Deep Sea off the Coast of Spain. By Prof. P. Martin Duncan, M.B. Lond., F.R.S., F.L.S., &c.

[Read February 17, 1881.]

(Plates XXIV. & XXV.)

During one of the dredgings of the Expedition of H.M.S. 'Porcupine,' in 1095 fathoms, off the south-west coast of Spain, a mass of fistulose coral was brought up; it included in its branches many foreign substances, and amongst them two small siliceous sponges. The coral was described by me in my monograph of the deep-sea corals*; and lately my attention has been drawn to the beautiful sponges.

One of them, about an inch in height and one third of an inch in thickness, has numerous oscules on it, and it is perfect in its hard parts. Of the soft tissues no idea can be obtained. The sponge evidently belongs to the Lithistidæ; for the skeletal elements branch after the fashion of the group, interlock at their ends with more or less filigreed terminations, producing a continuous network, and there are connective peltate spicula on the outside.

The sponge-body is very hard and resisting; but it is smooth to the touch and eye, and is of a dirty white colour; the outside of the body is faintly wrinkled here and there, and is produced on the flanks and at the apex into several wart-like elevations, each terminating in an oscule which leads deeply into the mass. The oscular processes are short, unequal, differently directed, and

* Trans. Zool. Soc. vol. viii. pt. v. p. 327.

have their bases sloping gradually on to the body. The oscular openings are unequal in size, are crateriform, and their wall is evidently stout. (Plate XXIV. fig. 1.)

A transverse section of the body reveals a thin dense cortical part, enclosing a lax sponge-like internal structure, with cavities and canals of different sizes; and these end externally in the oscular projections. (Plate XXIV. fig. 2.)

The cortical part exhibits a totally different structure to that within, and is dense and close; it forms the outside of the body and of the oscular processes. No pores are visible on the outside of the body with the naked eye; but the microscope reveals minute spaces between the margins of the foliato-expando-ternate spicula of the derm. Water enters very readily through the dense cortex into the interior.

A section through the sponge-body, made sufficiently thin to be used under transmitted light, without disturbing the position of the structural elements, revealed the histology; and a thin slice made parallel with the surface enabled its details to be satisfactorily described and figured.

The transverse section shows the dark line of the dense but thin cortex on the outside, and within it concentric layers of spicula grouped in different manners, the outer layer being connected with the connective spicula of the cortex by means of short, stout, cylindrical processes. No free stems project inwards from the foliated edged peltate-looking, connective spicula just noticed; for the stems are invariably attached to the proper spicula of the body just within. These outer proper spicula of the body are in very close order, and within them is a series of radial spicula massed into radial columns with spaces between them, giving the appearance of rather a lax tissue. The columns impinge, internally, on a thick concentric layer of shorter spicula much confused; and this is attached within to a columnar layer like that external to it. This alternation of close and open concentric layers is repeated several times with more or less regularity.

The result of this arrangement and grouping of spicula is to develope a series of moderately sized spaces in concentric series, and to establish a less permeable set of layers between them. Here and there the spaces become larger, and in some places small *cul-de-sacs* or tubes are formed; but it is done at the expense of the concentric close layers which abort; and the long

spicula are then either doubled in number or are greatly enlarged radially. Some have the limbs by which they usually unite to the shorter spicula of the concentric layers greatly enlarged and curved, so as to include more or less of the side of a tube (Plate XXIV. fig. 3). Near the larger canals in the interior, the concentric and radial arrangements are lost, and a confused tissue, consisting of medium-sized spicula uniting by very spinulose and ragged ends, exists. The bunched masses of spicular endings give an opacity which is very difficult to overcome (Plate XXIV. figs. 4–7). In portions of the section, the columns are so thick as to render the distinction into concentric and radial parts uncertain.

The spicula of the interior of the body vary much in size, and are, as a rule, beautifully transparent. The trifid outline prevails, and the fourth limb usually exists, but sometimes it does not, or is invisible.

Curved limbs ending in ragged, semi-spinose, or flat processes are common; but this raggedness is not long or in excess. It is often toned down into a series of short blunt projections, which are rather opaque and reflect light strongly.

In the columns, one limb of the spicule is always greatly developed, being long and narrowest centrally; and the other limbs are small, being sometimes indistinguishable from the irregular junction part.

The articular processes at the ends of the limbs are excessively irregular in shape, not very close, and rather short as a rule. Projections occur on all sides of the ending limbs; but they are rare on the main one (Plate XXIV. fig. 3), where isolated spinules are not uncommon. The spicula which join on to the ends of these radial ones are more compact, and their limbs are more equal; they are smaller than the others, and some are minute, forming an excessively close areolation. In the first instance the curvatures of the spicula are very decided, and the ends of the limbs are ragged (Plate XXIV. fig. 4); their surface is sparsely ornamented with dot-like projections, circular in outline. In the second case, the minute spicula run into each other at the limb-ends, with or without ragged projections; and the various angles of junction produce an incoherent arrangement (Plate XXIV. figs. 4–6).

These smaller spicula are trifid and quadrifid. Where separable, they present fractures and nodular points at the edge of the

arms (Plate XXIV. fig. 6) and little fixed spinules on the edge of the limbs. The spaces produced by the junction of these spicula are very small, and are intruded upon by the ornamentation as well as, to a certain extent, by the spicular arrangement of the limb-end. This more or less close structure is increased by the presence of minute acute-pointed spicula seated on the limb-ends (Plate XXIV. fig. 7); those of approximate limb-ends interlock. In many instances the junction is by simple contact of smooth surfaces, without the intervention of this minute spinulose element, or by flattened-out disks and ragged ends. Throughout, the peculiarity of the spicula is their general plainness and their scanty ornamentation of projecting spinules, sharp or blunt-headed.

The bases of the large spicula of the columns merge into or join, by ragged junction, short, stout, and irregularly shaped spicula, with a limb curved outwards towards the periphery (Plate XXIV. fig. 8). These last form the groundwork of the cortex, and they are crowded, the spaces formed by their junctions being very small. Their curved outer limb is covered with short and thick projections, more or less cylindrical and expanding outwards, where they are often ragged (Plate XXIV. fig. 8). These processes form a layer just within the outside of the cortex; and as they are close and their interspaces are excessively small, there is an approach to solidity.

The last kind of spicule to be noticed (Plate XXIV. fig. 9) forms the outside of the sponge, and consists of a very short base, which is narrow and more or less circular in transverse outline, and a widely expanded part perpendicular to the base and placed with its baseless face outwards. The expanded parts of these peltate spicula produce the smooth glistening surface of the sponge. Their shape is, moreover, very remarkable. An original trifid arrangement can sometimes be traced, and the stumpy cylindrical stem is the fourth limb; but each of the tripartite portions is broken up into a series of very ragged, deeply incised, dendritic-looking processes. These branch and rebranch, and terminate in minute ramuscules, ending often in minute sharp points arranged in a most ragged and eccentric manner. The ramifications give a dendritic appearance to these connective spicula, and, to a certain extent, they interlock with those of their neighbours. The spaces left between the ramifications are small and microscopic and act as pores. The absence of free stems to these foliato-expando-ternates has been already noticed, and hence the sponge is rigid.

No flesh-spicules exist on the outside of the cortex, and there is not a trace of any within. A few *Globigerinæ* and two or three long and small attenuate spicula were detected; but they evidently are foreign bodies, one spicule exhibiting the results of decay.

The specimen is characterized by its cylindrical shape and external oscular processes, its smooth and glistening surface, its dense derm of connective foliato-expando-ternate spicula highly dendritic at the edges, its close outer body-spicula with their cylindrical processes of attachment for the connective spicula of the derm, its alternating open and close main structure, with the highly spinulate nature of the quadrifid or tetraclade spicula, and by its deficiency of free stems to the connective spicula, and of all acerates and acuates and other minute sarcodic forms.

The form is evidently a Lithistid amongst the Siliceo-fibrous Spongida; and it is indistinctly tetraclade. Amongst the known species of Lithistids with surface-spicula with dendritic edges are *MacAndrewia azorica*, Gray, which probably is the same thing as *Corallistes clavatella*, Schmidt, and *Kaliapsis cidaris*, Bow.

The new form is neither of these, which, moreover, have flesh-spicula acerate, fusiform, curved, and microspined. I do not wish to establish a new genus from the main characters of this interesting Sponge, and propose to defer the consideration of its classificatory position for a time. Certainly the fixity of the connective derm-spicula is very remarkable. Bowerbank very properly insisted upon the great importance of the free end of the peltate spicula in the growth and swelling out of the sponge; it enabled the cortex to separate more or less from the body. But in this form every part was rigid; and in order to grow, the whole of the derm-spicula must have become deciduous. Lately Carter has expressed his belief that the derm-spicula become skeleton forms during growth; but it does not appear possible in this instance.

The second specimen of Sponge is cup-shaped, with a narrow, cylindrical, short base expanding below into a ragged foot. It is about half an inch in height, and is composed of one layer of network of continuous siliceous spicules. The spaces are large, and the solid part is broken up into minor spaces. Outside are the relics of a derm crowded with derm-spicula. The form clearly belongs to the genus *Aphrocallistes*, Wright. (Perceval Wright,

Aphrocallistes Bocagei, Q. J. Micr. Sci. 1870, p. 4. Fistulous branching sponge.)

Carter, enlarging on the diagnosis, gives a careful description of the species (Quart. Journ. Micr. Sci. vol. xii. p. 450). He notices that, besides the common large sexradiate spicula on which the vitreous structure is based, there are several other kinds, all of which are more or less free from the vitreous mass. Of these, the brush-spicule, and the rosette with three rays to each arm, are common in the specimen under consideration, and the scopuline spicula also.

The form under consideration is a young one and not a fractured old one. At one spot on the free edge the process of mesh-making can be well seen to be due, both to the collection of silica around previously existing hexactinellid or quinqueradiate spicula, and also to the growth of irregular siliceous threads in the sarcode, irrespectively of any geometrical form. The dermal spicula differ in many points from those which have been published as characteristic of *Aphrocallistes*, but some of the normal kinds are present.

Derm.—Very slender, long-rayed, hexactinellid spicula. The stem is as slender as the rays, but is shorter and straight. The rays are very slender, uniform in thickness, slightly bent, and long. At the junction is a slight swelling, and the prolongation of the axis is short and rounded off in a blunt spear-point. Sarcode adheres to the spicula, and extends between the rays.

The arms are separate from those of neighbouring spicula, or are under them, forming a discontinuous network (Plate XXV. fig. 2). These spicula are very numerous, and are found crowding the outside of the main skeleton and the derm which covered up the interstices. Often the vertical limb stands on the siliceous continuous skeleton, and the four at right angles to it then extend on all sides.

Slender, moderately long-rayed, hexactinellid spicula—the axial ray very long, above and below the plane of the others, in one direction slightly curved, and jagged on the edge (Plate XXV. fig. 3). Small hexactinellid spicula—the axis on one side of the plane of the radii, minutely ascendingly spinulose (Plate XXV. fig. 7). Others with the spinules standing out at right angles to the axial ray, and very minutely rugose about the rays also (Plate XXV. figs. 4 and 5). Moderate-sized hexactinellids—the radii stout and attenuating, and one of the axial rays also; the others slightly shorter, and closely but sparely spinulate in whorls,

the spinules being rather long and curved, the points looking obliquely from the stem. This brush-shaped form lies with the brush on the derm and not projecting (Plate XXV. fig. 8).

Hexactinellid spicula—the four rays minutely serrate and spined, not quite straight; the lower part of the basal ray rather short and attenuate, and the upper shorter, but ending in a collar around a knob; both hirsute, with minute very short spinules (Plate XXV. fig. 13).

Small, short-rayed, minutely spinulose or serrate, hexactinellid spicula (Plate XXV. fig. 14). Short, stout-rayed, hexactinellid spicula, with a long, fusiform, axial fibre (Plate XXV. fig. 15).

There are also three small kinds of the ordinary quinqueradiate type, the axis being prolonged as a sixth ray into a small knob; their size varies, and they form a discontinuous network within the larger forms; and many are in contact with the reticulate skeleton.

Spinulo-recurvo-polydentate spicula of exquisite delicacy. The spinule is long, swollen near the head, and narrowed off at the further end. The watchglass-shaped head has a fringe of numerous, recurvate, long and slender processes of great tenuity; they resemble the prolongations of the rosette of *Rhabdodictyon delicatum*, Schmidt. They are in the derm, and appear to stand out from it. (Plate XXV. fig. 5.)

Very small, multiradiate, burr-shaped rosettes. The short, very linear nine or ten radii, arising from a common centre, end in slight club-shaped knobs, rather thickest where they spring from the radii, and bluntly spear-shaped at the end. The whole is situate at the extremity of a long needle-shaped spiculum, which runs into the sarcode. Some of these approach the "spinulo-multifurcate sexradiate stellate" spicula of Bowerbank; but the sexradiate intermediate part is rather indistinct. They are numerous in the derm. Others are "spinulo-trifurcate" (Plate XXV. fig. 11) and "spinulo-bifurcate" (Plate XXV. fig. 12). Minute sexradiates, one limb very small; all the rest trifurcate at their ends (Plate XXV. fig. 9). Larger forms, the axis being a long fusiform ray extending on both sides of the plane of the four rays, each of which is very small, and two are terminated by a trifid extremity (Plate XXV. fig. 10).

The projections from the thick continuous skeleton-fibres are:—(1) stout at their origin, and sloping down to a fine spicule-shaped process of various lengths; (2) stout at their origin, and rather

suddenly diminishing, and then being prolonged in a fine cylindrical spine (Plate XXV. fig. 17); (3) very fine cylindrical spines, as slender as the long attenuate spicula, lying on the skeleton, and long enough to cross a space between the meshes; (4) short, cylindrical, slender-stemmed, club-topped, spinulose projections, and some of greater length (Plate XXV. fig. 18). At the base of the body, however, the reticulation is of a very different character to that seen elsewhere; it is smaller, closer, and consists of a vast number of hexactinellid spicules turned into skeletal tissue by exogenous increase of silica. The arrangement is continuous; but there are no wide interspaces. Long spicula are seen here and there, cylindrical and attenuate.

At the free growing edge, the skeleton of the body is in a most rudimentary state; and it is evident that two sets of spicula are forming the lattice-work—hexactinellids and quinqueradiates. But there is a very irregular broken net-looking mesh of siliceous fibres, in which the shape of the ordinary spicule is not traced. This irregular structure covers much space, has a derm on it in some places; and it appears to have been produced by the sarcode, and not through the intervention of joining spicula (Plate XXV. fig. 19).

Here and there long, very tapering, attenuate spicula, more or less closely spinuled, or rather serrated, are in contact with the skeleton of the meshes (Plate XXV. fig. 16); and they are in contact with others which are not spinuled; and both sets overlap, and form a structure between the derm and the skeleton.

The meshes of the body-skeleton are moderately uniform in thickness in some parts, and the spaces between the interspaces are wide, on the whole, in the stem of the sponge. The skeleton of the mesh is very reticulate, and unequal in size, and usually the surface of the large continuous spicula is granular. The spiniform projections are numerous, and many cross nearly or quite over an interspace. The resemblance of the skeleton to that of *Aphrocallistes Bocagei*, Wright, is considerable in some parts; but it is interesting to note the structure of the base and the variety of the spicule elements, as affording distinctions of more or less value.

Oscar Schmidt, in his 'Spongien der Meerbusen von Mexico' (Jena, 1880), names a form which is by no means unlike that now under consideration in shape; but even the very short

and insufficient diagnosis of *Cyathella lutea* suffices to distinguish one from the other (Schmidt, *op. cit.* p. 46, Taf. vii. fig. 2).

A still greater resemblance in shape exists between the new form and *Rhabdodictyon delicatum*, Schmidt (*op. cit.* p. 46, Taf. vii. fig. 3); but the beautiful rosette of this very lax-meshed Mexican-sea species is not distinctive. The rest of Schmidt's diagnosis is insufficient to establish a species.

On the seventh plate of the same work, Schmidt gives some figures of *Aphrocallistes Bocagei*; and one is interesting (fig. 5 B), for it indicates a young specimen with its base. It is, as far as its lower third is concerned, very much of the size, and resembles in shape, the new form; but there are no indications of the peculiar basal structure just described.

Finally, there are some points of resemblance, but not sufficient to necessitate a generic alliance, with *Aulodictyon*, S. Kent.

DESCRIPTION OF THE PLATES.

Plate XXIV.

The Lithistid sponge.

Fig. 1. The body, natural size.
2. A transverse section, natural size.
2 *a*. The same, magnified.
3. Large column-spicula of the radial open structure, magnified.
4. A spicule of the concentric close structure, magnified.
5. Smaller spicula from the same region, magnified.
6. Spicula with spinuled limbs, magnified.
7. Spinules, magnified, of preceding fig. 6.
8. Contact spicula, with minute spinulose junctions, magnified.
9. The spicula just within the cortex, magnified.
10. Peltate cortex, dendritic, modified trifid spicula, magnified.

Plate XXV

Aphrocallistes sp.

Fig. 1. The specimen, natural size.
2. Large common derm-spicula, magnified.
3. Hexactinellids with long axis more or less ragged, magnified.
4, 5. Minute hexactinellids, magnified.
6. A multidentate scopuline, magnified.
7, 8. Brush-spicula, magnified.
9. Rosette, magnified.
10. An incomplete rosette, with a long axial fibre, magnified.
11. Rosettes, trifid, magnified.

Fig. 12. Attenuate straight-limbed, knobbed, simple rosette, magnified.
13. A spinulose hexactinellid spicule with knob, magnified.
14. An hexactinellid with serrate limbs, magnified.
15. An hexactinellid with prolonged axis, magnified.
16. A long, attenuate serrate fibre, magnified.
17. Plain processes of the skeleton, magnified.
18. Clubbed cylindrical spined processes, magnified.
19. The lattice-work at the free edge, magnified.
20. The lattice-work of the base, magnified.

On Individual Variation in the Branchial Sac of Simple Ascidians. By W. A. Herdman, D.Sc., F.L.S., F.R.S.E.

[Read April 21, 1881.]

The difficulty of determining the value of specific characters in Ascidians is well known to all who have worked at the group. It is now universally admitted that the old method of describing merely the external appearance of the animal is insufficient; as in many cases it is impossible, from an examination of the external characters alone, to determine the genus, and even in some cases the family, to which the specimen belongs. Consequently, most writers on the Tunicata in recent years have described in more or less detail certain internal characters, including the branchial sac and its related organs, the circlet of tentacles, the dorsal lamina, and the olfactory tubercle. The conditions of these important structures furnish most valuable generic and specific characters, and an account of them should undoubtedly form part of the description of an Ascidian.

It must not be forgotten, however, that some of these characters, in many species, vary considerably according to the individual; or, in other words, not only do varieties exist, but most individuals differ slightly from each other in points which are given as specific characters: this, of course, is only in certain species. Hence when the number of specimens for comparison is small, it is often a delicate matter to determine what is a good species.

My attention was first directed to this variation by reading Lacaze-Duthiers's description, in his great work on the Molgulidæ *, of three marked varieties of branchial sac in *Ctenicella Lanceplaini*, L.-Duth. This appears, however, from the account given, to be a

* H. de Lacaze-Duthiers, "Histoire des Ascidies simples des côtes de France," 2e partie, 'Archives de Zoologie expérimentale et générale,' t. vi. p. 619, pl. xxiii. figs. 9, 10, 11 (1877).

case of marked and permanent varieties, and not merely of individual variation. The irregular portion of a branchial sac of *Ascidia scabra*, which I recently figured in the Journal of this Society (*anteà*, p. 284, Pl. XVII. fig. 3), I regard, on the other hand, as merely a local abnormality which I think may be accounted for by the splitting or branching of several neighbouring transverse vessels. I have since met with an exactly similar case of great irregularity in a branchial sac of *Ascidia virginea*, O. F. Müller.

In order to try and determine the extent of individual variation in the branchial sac, and so satisfy myself as to what characters are most constant and may be relied upon in the determination of species, I lately examined minutely the branchial sacs of several of our commonest species of simple Ascidians, of which I had a sufficient number of specimens at my disposal. The conclusion I have come to is interesting, but rather unsatisfactory—namely, that certain characters, such as the relative sizes and arrangement of the transverse vessels, the number and position of the internal longitudinal bars, the shape of the meshes, and the number of stigmata they contain, are highly characteristic of some species, and not at all so of others *.

A marked example of the latter class is *Styela grossularia*, v. Beneden, which has such a variable branchial sac that it is almost impossible to obtain specific characters from its details. This species belongs to the Cynthiidæ, one of the characters of which is that the branchial sac is longitudinally folded. The normal number of folds in the genus *Styela* is eight, four on each side; but in this species the folds are almost obsolete, being entirely wanting on the left side, and reduced to one on the right. Even that one can hardly be called a fold; it is merely a slight bulging inwards, or projection of the branchial sac, on which there are a number of closely approximated internal longitudinal bars. This single representative of the enormous folds found in most Cynthiidæ and Molgulidæ is situated in the dorsal part of the right side, and is separated from the dorsal lamina by a broad space free from internal longitudinal bars. A similar space is present on the left side of the dorsal lamina and two others at the ventral edge of the sac, one on each side of the endostyle. These spaces are always larger than the ordinary meshes; but they vary greatly in size in dif-

* I have lately arrived at similar results after an examination of the so-called "olfactory tubercle" as a specific character. (See 'Proc. Roy. Phys. Soc. Edin.' vol. vi.)

ferent individuals. The stigmata are, as a rule, of much the same width; and consequently we may take the number of stigmata in these spaces as a measure of their extent. The commonest number of stigmata observed was sixteen, but numbers down to twelve were frequent, and in one case ten only were present: only once were more than sixteen observed, and in that case there were twenty-three!

The number of internal longitudinal bars on the fold varies from six to nine, and is generally eight or nine. The rest of the right side of the branchial sac, between the fold and the ventral clear space, is divided by the internal longitudinal bars into meshes of varying size, and containing each from two to eight stigmata. The prevailing numbers are six, seven, and eight; but here and there one comes across smaller meshes, generally two or three together, containing each three or four (usually three, rarely two) stigmata.

On the left side of the branchial sac after the dorsal clear space, and therefore in a corresponding position to the fold on the right side, we invariably come upon one or more (generally two or three) of these narrow meshes; and they occur several times between this point and the ventral clear space, just as they do on the right side. There can be little doubt, I think, that these narrow meshes are the almost obliterated or rudimentary representatives of the missing folds. In several new species of *Styela* in the 'Challenger' collection the folds in the branchial sac are in even a more rudimentary condition than the single fold of *Styela grossularia*. They are merely tracts in which the internal longitudinal bars are numerous and closely placed. Now these narrow meshes in the present species are caused merely by three or four internal longitudinal bars being placed more closely together than in the rest of the area. Then the invariable occurrence of three or four of them on the left side next the dorsal clear space seems to indicate that they represent the fold in the corresponding position on the right side. Finally, they form generally three or four longitudinal lines down each side of the branchial sac, and four (one of which is frequently very slight) is the normal number of folds in the genus.

The branchial sac of *Ascidia plebeia*, Alder, has a very characteristic appearance, and is very constant in the size of the meshes, papillæ, &c. There is one point in its structure, however, which seems liable to variation. As a rule, the transverse vessels are all

of the same calibre; but in several specimens which I have examined every fourth vessel is much wider than the intervening three.

In *Ciona intestinalis* the meshes vary somewhat in size in different individuals, but according to no apparent method. Five stigmata in a mesh seems the normal arrangement; four and six are frequently met with, larger numbers more rarely, while ten is the utmost I have observed.

One form of variation remains to be mentioned, viz. the presence of delicate horizontal vessels placed irregularly between the transverse vessels and dividing the meshes into two parts. *Ascidia aspersa*, O. F. Müller, is an example of a species in which these vessels occur as an individual variation. In typical specimens the transverse vessels are all of the same size, and the meshes are square and undivided; but in some individuals many of the meshes (not all) are traversed by these delicate horizontal vessels, and so divided into pairs of transversely elongated areas.

Notwithstanding this liability to individual variation in the branchial sac of at least some species, there is no doubt that the organ is of primary importance in specification. It consequently seems most advisable, in the description of new species, where a sufficient number of specimens is not available to determine which points are constant in the species, to describe the branchial sac and other important organs minutely, so that subsequent investigators may have details of structure in sufficient number to warrant them in assuming that the great majority are constant characters, and that only a few, probably, are liable to variation in any one individual of the species.

The Parasites of Elephants. By T. Spencer Cobbold, M.D., F.R.S., F.L.S., Foreign Mem. Roy. Agric. Acad. Turin.

[Read April 7, 1881. Abstract.]

This contribution, which will be published in the Society's 'Transactions,' with appropriate illustrations, deals with fourteen species, of which twelve are entozoal. The first recorded (*Ascaris lonchoptera*) was taken from a captive animal destroyed at Geneva on account of madness. Two species were described by the late Dr. Baird, but some remarkable peculiarities of structure in *Sclerostoma sipunculiforme* and *S. clathratum* had been overlooked. Four new Nematodes are added (*Strongylus foliatus*, *S. falcifer*, *Dochmius Sangeri*, and *Filaria Smithii*). The last species and one of the Strongyles were found in singular growths or abodes formed within the walls of the elephant's stomach. Three new species of *Amphistoma* (*A. Hawkesii*, *A. ornatum*, and *A. papillatum*) are described. In the fresh state these beautiful little parasites are transparent and of a bright pink colour. Many new particulars are given in respect of the fluke (*Fasciola Jacksoni*) described to the Society in 1869. The larval state of *Gastrophilus elephantis* is also fully noticed. Specimens of this '*bot*' were exhibited from an African elephant shot by Dr. Kirk. Remarks were also made respecting the curious parasitic ova observed by Mr. Sclater and Prof. Flower on tusks now preserved in the Museum of the Royal College of Surgeons. After referring to *Hæmatomyzus* and *Homopus* of Piaget and Mégnin respectively, the paper concluded with a record of facts pointing to the destructive effects of the flukes, roundworms, and Amphistomes. The epidemic affecting Sanger's performing elephants was attributable to this cause.

On the Occurrence of the Norwegian *Argentina silus** on the Shore of the Moray Firth, Banffshire. By Thomas Edward, A.L.S.

[Read April 21, 1881.]

The present being one among the few instances of the capture of this species in the British seas, the writer presumes that a notice of the fact, with an account of the fish itself, may not be uninteresting to the members of the Linnean Society.

The fish alluded to was taken about the end of October, 1879, nearly thirteen miles west from the town of Banff, and was sent to me for examination, as none of the fishermen had seen one of the same kind before. It was also new to me. With the aid of two friends, Professors Trail and Ewart, of Aberdeen University, I was enabled definitely to identify it as here named in the title of the paper, though previously to this Dr. Günther had hinted by letter that it might be *Argentina silus*.

Description of the Fish.—Length $8\frac{1}{4}$ inches. Height of body near shoulders (where the fish is deepest) about 1 inch. Circumference at same place over 2 inches, near the tail scarcely 1. Length of head $1\frac{3}{4}$ inch, which tapers considerably towards the mouth, which is very small and gives the head a most remarkable appearance. Breadth behind the eye 1 inch. Length of tail (which is deeply forked) $1\frac{1}{2}$ inch. Dorsal fin in front nearly $1\frac{1}{2}$ inch in height and pointed, the first ray being the longest, the others shortening as they go backwards. Adipose fin about $\frac{1}{2}$ inch in height, is rather boomerang-shaped, and placed only $\frac{1}{2}$ inch from the root of the caudal, its insertion being in direct line with the centre of the anal. Pectorals rather pointed and over 1 inch in length. Ventrals nearly an inch, and broadish at their tips. Anal fin at its commencement $\frac{3}{4}$ of an inch, but lessens towards its extremity, which is within $\frac{1}{2}$ inch of the tail. The dorsal fin

* When this paper was written and forwarded to the Society I was under the impression that the species had not hitherto been obtained on the British coasts. My isolated position did not enable me to consult books or museums, and a copy of the Society's Journal containing Dr. Francis Day's paper "On the Hebridal Argentine" (Journ. Linn. Soc. vol. xv. p. 78, pl. iv.), not having then reached me, I was unaware of the most recent notice of the fish in question, and of its determination with the *Argentina sphyræna*, Linn. I would gladly have withdrawn my paper on learning of Dr. Day's; but the Council of the Society have thought fit to print it, as an additional record of a fish whereof only three British specimens have previously been taken.

commences about $1\frac{1}{2}$ inch from the head; ventrals nearly opposite where the dorsal ends; pectorals close to the gill-covers. The fin-rays, so far as I could make them out, are as follows:—D. 9, P. 13, V. 14, A. 11 to 12, C. 24.

I may mention, however, that the fins were somewhat hardened and contracted, the fish having been dead some days before it reached me.

The most important and peculiar characteristic of the fish is the shape of its body. In this respect it is decidedly in part hexagonal and in another heptangular. Thus in a great measure its small contracted mouth resembles the Syngnathidæ, or pipe-fishes; but at the same time it differs widely in every other respect. In the adipose appendage and the disposition of its fins it approaches the Salmonidæ; but here again it differs as materially, if not more so, from this tribe in the form of its body.

Another special and interesting peculiarity, which is not found in either of the families alluded to, although met with in the keel of the Clupeidæ, is that each division of the body is distinctly separated by a visible ridge, which, in most cases, are minutely but very sharply serrated. These serrations may be felt by passing the finger downwards from the head. The sensation and peculiar irritation, though not an unpleasant one, resembles that given to the hand when rubbed gently along a very finely cut saw. This is particularly the case with the parts at the centre of the belly, which latter, like the back, is distinctly divided by a raised ridge or keel; the serrations here seem to be stronger and larger than on the other ridges.

The back is nearly $\frac{3}{4}$ of an inch broad, the first compartment about $\frac{1}{4}$ inch, the other a little more and bounded by the lateral line, which is straight. The stripe immediately below it is the broadest of all, being $1\frac{1}{2}$ inch, the others get narrower as they descend. Belly not quite so broad as the back.

As the number of divisions so are the number of colours, each being mostly of a different hue. That on the back would seem to have been of a deep amber tint, the next, sidewise, being greenish blue, the other silvery grey, the one below the lateral line being of a pure silvery white, with a bright metallic lustre, the others only a little fainter, but very similar to those above; belly greyish white, with a tinge of greenish blue and purple. The head on the top had been nearly the same as the back, with

the sides silvery. The large eye has a very bright silvery iris and a bluish-black pupil.

Another very noticeable feature of the fish was (and this took the attention and excited the admiration of others as well as myself) that, turn it whichever way you like, the glistening of the various stripes had a most beautiful and pleasing effect, exhibiting all the colours of the rainbow, the harmonious iridescence being visible whether looked at from before backwards or the reverse; when alive, doubtless, it may even have been more brilliant.

One more peculiarity of the fish, and a most striking one, is that, though about an inch in thickness, the flesh is so transparent that you can see the vertebræ quite distinctly by holding it up to the light.

From what has already been stated concerning the mouth, no one will wonder when they are told that I could only make out the gape to be $\frac{1}{4}$ of an inch.

On looking into the minute oral aperture, I could see that the upper jaw was thickly beset with numerous small teeth, but could discover none on the lower jaw. The tongue was almost covered with two large strong teeth, one on each side, and curved backwards; betwixt these there were others of a like form, but much smaller.

I may here further mention that there is a small fleshy protuberance or wart at the tip on the underside of the lower jaw.

On dissection the specimen proved to be a male, but as to its probable maturity I venture to offer no opinion. The milt, which was of a chalky whiteness and $1\frac{1}{4}$ inch in length, did not seem to me to be full; it might have been partly spent.

The stomach contained the remains of a few of the smaller crustaceans, such as *Darwinia compressa* and *Proto pedata*, &c., also fragments of *Sertularia filicula* and *Antennularia antennaria*, &c. This may show, or at least give, an indication that its habitat is amongst the corallines, and that its small pointed-like mouth is well adapted for picking off the minute zoophytes from their horny stems. Its form, too, is such as to enable it to glide with perfect ease, and its large eyes to see its way through amongst the countless animal forests which everywhere clothe that part of the ocean where it seems to live and sport.

On the Green Colour of the Hair of Sloths. By H. C. Sorby, LL.D., F.R.S., F.L.S., V.P.G.S.

[Read April 7, 1881.]

Some years ago the late Mr. E. R. Alston called my attention to the green colour of the hair of *Bradypus castaniceps*, noticed by Seemann, who had inquired of Dr. J. E. Gray whether he knew any green species of Sloth, for that such was the colour of one living in Nicaragua. Seemann, in a letter quoted by Gray in a paper in the 'Proceedings of the Zoological Society'*, raised the question whether this green tint, so abnormal in mammals, might not be due to a parasitic alga; and suggested that one reason why the animal was so seldom seen was that the coarse hair, thus coloured, made the creature look almost exactly like a mass of the so-called vegetable horsehair (*Tillandsia usneoides*), so common on the trees of the district where the Sloth occurs. Little or no further attention appears to have been directed to this question in England; and neither Mr. Alston or myself had any idea that it had been carefully studied in Germany. On examining, both microscopically and spectroscopically, some of the hair from Seemann's specimen, which had retained its colour where not exposed to the light, and comparing it with specimens from *Cholopus Hoffmanni*, I was soon convinced that Seemann's explanation was correct; and after I had devoted a considerable amount of time to this subject, Mr. Alston accidentally found that Welcker and Kühn had published a very complete memoir on the growth and structure of the hair of Sloths and on the algæ parasitic on them†. I cannot therefore lay claim to having been the first discoverer of these organisms, but have worked out the question in an independent and different manner, and observed some facts which are not described in the paper just cited.

In the first place, I have had the advantage of studying fresh material, and not, like previous authors, merely specimens that had been kept long in museums, which was perhaps the reason why the general green colour of the hair is not alluded to by Welcker and Kühn. Early in the year 1877 a *Cholopus* was sent to the Zoological Society's Gardens direct from its habitat, which died very soon after its arrival; and Mr. Bartlett kindly placed

* 1871, p. 429.

† Abhand. der naturf. Ges. zu Halle, 1866, vol. ix. p. 20.

the entire skin at my disposal. I have also had the advantage of studying the hair of specimens which had lived some years in England; and was thus able to learn that none of the green algæ grew on the hair in the dry atmosphere of the house in the Gardens, whereas on that of the animal fresh from its native damp woods the number on the hair from some parts of the skin was so great as to give rise to a most unmistakable green colour, not seen in the case of the animals which have lived some time in this country. It therefore appears that the growth of the alga depends partly on the damp character of the locality in which the Sloths live. I, however, think that it also depends, in great measure, on the most exceptional and remarkable structure of the hair of Sloths; and after having carefully studied that of very many other animals, I must say that it appears to me not at all probable that algæ would grow on the hair of other mammals, even in damp localities.

For my present purpose it is convenient to look upon hair as a very variable mixture of dense horn and a highly cellular pithy substance, containing much air. As an example of one extreme, I may refer to the bristles of the wild boar, which are generally almost exclusively composed of dense horn. In many animals the hair consists of a solid external sheath of horn, with a central pithy core, the relative size of which varies much; and in the case of nearly all Deer and some Antelopes and allied animals this central pith constitutes nearly the whole, and the external horny layer is very thin. In all these cases this layer is continuous over the whole exterior; and though sometimes the surface is rough and scaly, yet in many cases it is almost or quite smooth and glossy.

The hair of *Cholopus* (figs. 4 & 5) differs in a most remarkable manner from all others that I have examined. Instead of the horny exterior being continuous, it is more or less deeply fluted longitudinally, right down to the central pith, which is thus exposed along the bottom of the numerous grooves (fig. 4). The growth of the green algæ is most unmistakably related to this structure. None grow on the surface of the bright glossy ribs, whereas all along the depressions they abound, so that we see clear polished ribs and deep green hollows extending longitudinally along each hair (fig. 5). I do not see how we can doubt that this special localization is due to the fact that the surface of the grooves is rougher, as well as more protected from friction, than the ribs.

Probably this influence of friction is the reason why the general green colour of the hair is so much better marked in some parts of the animal than in others, being more especially visible at the back of the head and neck.

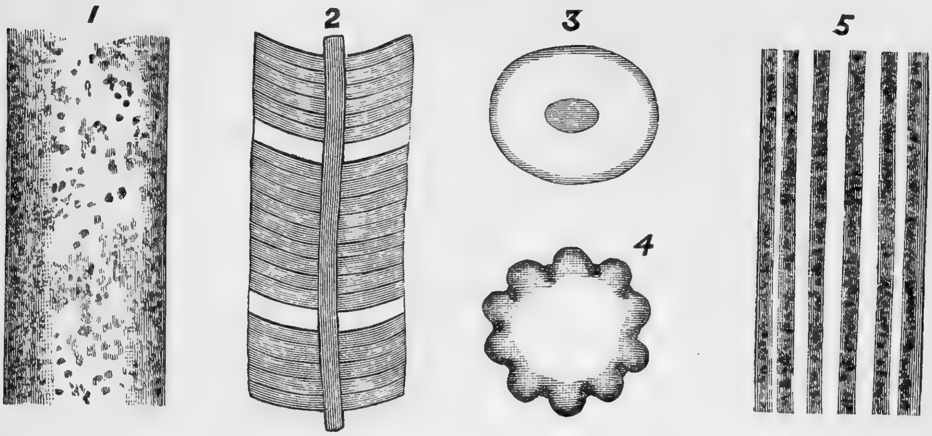


Fig. 1. Hair of *Bradypus* with algæ on surface.
2. The same, old and cracked.
3. The same, transverse section.
4. Hair of *Cholopus*, transverse section.
5. The same, surface with algæ in hollows.

The structure of the hair of *Bradypus* (figs. 1, 2, & 3) differs as much from that of *Cholopus* as from that of all other animals* which have come under my observation; and in fact we might almost say that it is the reverse of the normal. Instead of there being a horny sheath and a central cellular pith, there is a central horny thread (fig. 3) and a pithy exterior, with somewhat oblique transverse structure, made much more transparent when saturated with Canada balsam. The result of this remarkable structure is that old hairs break up into numerous segments (fig. 2), which look like angular beads strung on a central horny thread, so as to make the hair, roughly speaking, somewhat like the barbs of certain feathers with attached barbules. It is on this external pithy portion of the hair that the green algæ grow (fig. 1); and I am disposed to believe that they are able to grow on it mainly because the surface is sufficiently rough to allow them to attach themselves so firmly that they are not easily removed by friction.

It will thus be seen that I attribute the presence of the algæ

[* There is a small Sloth, however, in which the larger hairs are quite smooth and solid.—Ed.]

on Sloth's hair quite as much to its exceptional structure as to the humidity of their habitat, and look upon this unusual growth of green parasitic plants as due to the combination of both conditions*. If the green colour is really a protection to the animal, one cannot help asking whether the structure of the hair is connected with this protection, either by design or by gradual development.

On examining the hairs in a natural state with the microscope every stage in the growth of the small green algæ can be seen; but many facts may be better observed by heating the hair in dilute caustic potash. This dissolves the horny substance of the hair, but leaves the algæ more or less free. There is then no difficulty in studying every phase of growth, from green specks of $\frac{1}{10,000}$ inch in diameter up to cells of $\frac{1}{2000}$ diameter; and they are seen dividing and subdividing in much the same manner as the cells of *Chlorococcum*, so common on damp walls and trees. Kühn describes those met with on the hair of *Bradypus* as differing from those on *Cholopus*, basing his conclusion, to a great extent, on the number and form of the spores. He names them respectively *Pleurococcus Bradypi* and *P. Cholœpi*. The plants certainly differ in several particulars; but one may doubt whether the difference is not due to difference of conditions. One grows on a comparatively flat surface, which allows of lateral extension; whereas the other grows in grooves, which allow of only free linear development. We cannot say whether the spores of the one form would grow into the other under changed conditions; but, at the same time, the different conditions may have led to the production of well-marked hereditary peculiarities. However, whether we call them species or varieties, at all events there can be no doubt that they are minute parasitic plants; but at the same time I thought it desirable to confirm this conclusion by the independent evidence of spectroscopic examination.

On heating in alcohol the hair of the *Cholopus* fresh from America, the colour was not dissolved, but it was readily soluble after the hair had been boiled in water, and yielded a fine green solution. This I studied very carefully, separating the different constituents in the manner described in my paper on comparative vegetable chromatology†, and compared it with the solution

[* The hair of Bats, it may be observed, seems adapted for a growth of algæ, so far as mere structure is concerned.—Ed.]

† Proceedings of Royal Society, 1873, xxi. p. 442.

obtained in a similar manner from *Chlorococcum.* Both contain the six different-coloured substances usually, if not invariably, met with in green algæ and in plants of higher organization, but in different relative proportion. The most striking fact was, that the variety of chlorophyll which I have named "yellow chlorophyll," characterized by a spectrum very different from that of the more abundant "blue chlorophyll," exists in a much larger relative amount than in plants of high organization, and even in larger amount than in other green algæ which I have examined, but perhaps not in larger than might very well occur in minute green algæ growing in damp tropical woods. On the contrary, what I have called "orange xanthophyll" occurs in smaller amount in the algæ from the hair than in *Chlorococcum.* I subjoin comparative analyses, which must be looked upon as only approximate. They, however, suffice to show most clearly that the green colour of the hair of Sloths is due to the presence of precisely the same colouring-matters as those found in green algæ, the difference being no greater than what may be due to small differences in conditions.

	Chlorococcum.	Sloth's hair.
Blue chlorophyll	48	53
Yellow ,,	10	17
Xanthophyll	16	17
Yellow xanthophyll	16	8
Orange ,,	6	1
Lichnoxanthine	4	4
	100	100

Descriptive Catalogue of the Species of *Cellepora* collected on the 'Challenger' Expedition. By George Busk, F.R.S., F.L.S.

[Published by permission of the Lords Commissioners of the Treasury.]

[Read May 5, 1881.]

The number of species here referred to the genus *Cellepora* is about 26 or 27.

Of these—

1. The *North-Atlantic* region yielded three, from depths varying from 51 to 450 fathoms.

2. The *South-Atlantic* furnished five, from depths varying from 5 to 600 fms.

3. The *Kerguelen* or *South-Indian region* yielded seven, all from the immediate neighbourhood of Kerguelen's Land, and from depths varying from 20 to 150 fms.

4. The *Australian region* afforded eleven species, all, with one exception (*C. solida*), from depths varying from 2 to probably not more than 40 fms. The exception is a very aberrant form, and only doubtfully referred to the genus; it was procured from a depth of 2600 fms.

5. The *North-Pacific region* furnished only two species, one at 18 and the other from 310 fms.; and

6. The *South-Pacific* three or four species, from depths varying from 45 to 150 fms., except in one rather curious instance, in which the specimen appears to have been brought up from 1325 fms., near the western coast of South America. The circumstance is curious, since the same species, *C. Eatonensis* (var. *magellensis*), occurred near the Falkland Islands at a depth of not more than 5 to 12 fms.

On the whole, the genus, as represented in the present collection, would appear to belong to comparatively shallow water.

Class POLYZOA.

Order Gymnolæmata.

Suborder Cheilostomata.

Fam. Celleporidæ.

Celleporidæ, *Johnst.*; *Brit. Mus. Cat.*; *Hincks, &c.*
Escharidæ (pars), *D'Orbigny.*
Myriozoidæ (pars), *Smitt.*

Char. Zoœcia urceolate, erect or suberect, irregularly heaped together, and often forming several superimposed layers.

Gen. 1. Cellepora.

Cellepora (pars), *Fabric.*; *Linn., &c.*
Cellepora, *Brit. Mus. Cat.*; *Johnst.*; *Hincks*; *auct.*
Tubipora (pars), *Linn.*
Millepora (pars), *Ellis & Solander.*
Celleporaria, *Lamx.*; *Reuss*; *D'Orb., &c.*
Spongites, *Oken.*

Char. Zoarium multiform, lamellar and incrusting and partially adnate, or free; or erect and attached by a thick base; massive or irregularly branched, solid or hollow; or in the shape of small parasitic, pisiform or discoid growths. *Zoœcia*, in the older portions, more or less erect or vertical, very irregularly disposed and heaped together. *Orifice* entire, or sinuated in front, with one or more small avicularia closely contiguous to it. Often a preoral rostral process (sometimes aborted), usually supporting an avicularium; very generally interspersed avicularia.

The species of *Cellepora* here enumerated may be artificially arranged into groups, characterized respectively by the form of the orifice, or, more accurately perhaps, by that of the oral valve or operculum; whilst a secondary division may be made from the characters afforded by the general zoarial habit†, which may be either incrusting or lamellar, or more or less solid, massive, branched, or lobate.

§ I. Border of the primary orifice entire; not sinuated or notched in front (Holostomatous).

1. C. hastigera.
2. C. apiculata.
3. C. nodulosa.
4. C. zamboangensis.
5. C. albirostris.
6. C. tridenticulata.
7. C. columnaris.
8. C. honolulensis.
9. C. imbellis.
10*. C. rudis.‡
11. C. solida.

§ II. Orifice notched or sinuated in front (Schizostomatous).

a. Incrusting or massive, branched or lobate.

1. C. Simonensis.
2. C. pustulata.
3. C. cylindriformis.
4. C. Eatonensis.
5*. C. ovalis.
6*. C. polymorpha.
7. C. tuberculata.
8*. C. vagans.
9. C. Jacksoniensis

β. Parasitic, usually pisiform.

10. C. bicornis.
11. C. bilabiata.
12. C. signata.
13. C. conica.
14. C. ansata.
15. C. canaliculata.
16. C. bidenticulata.

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† *Vide* Hincks, Brit. Mar. Polyzoa, vol. i. p. 398 *et seq.*

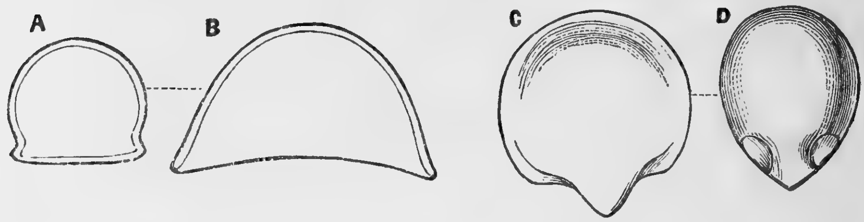
‡ In the species marked with an asterisk the form of the orifice does not accord with that of the operculum.

If the form of the operculum be taken as the character*, the species may be arranged as under :—

§ I. Operculum suborbicular, semicircular, or arcuate. (Woodcuts A & B.)

1. C. nodulosa.
2. C. hastigera.
3. C. albirostris.
4. C. ovalis.
5. C. columnaris.
6. C. polymorpha.
7. C. Jacksoniensis.
8. C. apiculata.
9. C. tridenticulata.
10. C. zamboangensis.
11. C. honolulensis.
12. C. vagans.
13. C. imbellis.

§ II. Operculum more or less pyriform or contracted below, with an articular notch on each side. (Woodcuts C & D.)



α. Massive, lobate, or incrusting.

1. C. tesselata.
2. C. Eatonensis.
3. C. rudis.
4. C. cylindriformis.

β. Pisiform, parasitic.

5. C. ansata.
6. C. bicornis.
7. C. canaliculata.
8. C. conica.
9. C. signata.
10. C. bidenticulata.
11. C. bilabiata.

Section I.

1. C. HASTIGERA, n. sp.†

Char. Zoarium erect, expanded, lobate. *Zoœcia* deeply immersed; surface entire dull. *Orifice* (primary) suborbicular, with a slightly sinuated lower border and no spines. *Preoral rostra* of two kinds—one, very stout and subconical, supporting on the posterior face, either at or near the apex or lower down, an avicularium, with either an acute or a duckbill-shaped mandible and a toothed beak; the other slenderer and very acute, with a small lateral avicularium at the base overhanging a notch.

Hab. St. 162. Bass Strait, 38–40 fms., sand.

* See paper by A. W. Waters in Proc. Lit. & Philos. Soc. Manch. 1878, vol. xvii. p. 125.

† "Chall. Rep." pl. xxix. fig. 1. The illustrative figures here referred to along with the name of each new species will appear in my Monograph of the 'Challenger' Polyzoa, now nearly completed.

In some respects the characters of this form render it doubtful whether it may not be a variety of *C. bispinata*, B.M. Cat., or *C.* (*Discopora*) *albirostris*, Smitt (Florid. Bryoz.); but the total absence of any sign of the two long slender oral spines in the marginal zoœcia, and the different form and proportions of the preoral rostral process, render them, in my opinion, sufficiently distinct.

2. C. APICULATA, n. sp.*

Char. Zoarium incrusting, or unilaminar and unattached. *Zoœcia* (at the growing edge) ventricose or barrel-shaped, with a granular unpunctured surface; in the older portions deeply immersed and very confusedly disposed, varying much also in size. *Primary orifice* semicircular, with a straight entire lower border, and surmounted in the earliest stage by two, or rarely three, long oral spines. *Preoral rostrum* very irregular in size, and supporting usually on one side a large avicularium, with an obtuse serrated beak, and a subacute lanceolate or triangular mandible, and usually produced beyond the avicularium into a longer or shorter obtuse apiculate spine.

Hab. St. 163 A. Off Port Jackson, 30–35 fms., rock.

The extreme irregularity of growth and great diversity in the form and size of the preoral rostrum, which is sometimes very small and at others developed into a very large avicularian process, renders any description of this species very difficult. The chief points at present are:—(1) the semicircular orifice (about 0″·07 wide) with a straight entire lower lip; (2) the, at first, short and thick *hollow* rostrum, which afterwards becomes produced into an obtuse spine, and on the side of the wider portion, some distance above the base, supports on one side a large avicularium with a finely serrated beak and rather blunt elongated mandible; (3) the presence on the youngest zoœcia only of two, or sometimes three, long oral spines, like those in *C. bispinata*, mihi, or *C. albirostris*, Smitt. The figure in "Chall. Rep." plate xxix. has unfortunately been taken from a very bad specimen, and shows little of the real characters.

3. C. NODULOSA, n. sp.

Char. Zoarium a rounded, irregularly nodular massive growth. *Zoœcia* perfectly upright, very deeply immersed below, often free above, and united in sets of three or four together. *Orifice* suborbicular or elliptical, about 0″·007 wide. A few excessively minute denticles within the lower border. *Operculum* subtrian-

* "Chall. Rep." pl. xxix. fig. 2.

gular rounded, about 0″·006 in diameter. *Preoral rostrum* small, conical, obtuse, most frequently represented by a mere transverse tuberosity. On the back a very minute avicularium with a semicircular mandible. *Oœcium* partially recumbent, free, with a wide arched opening, and frequently with a round pore on each side in front. Interspersed *avicularia* rare, columnar, vicarious. Mandible blunt, triangular; beak obtuse, not toothed.

Hab. St. 163 A. Off Port Jackson, 38–45 fms.

The open honeycomb aspect of this form and the peculiar habit (if constant) are very characteristic at first sight.

4. C. ZAMBOANGENSIS, n. sp.*

Char. Zoarium expanded thick, loosely adnate; surface uneven, but not distinctly mamillated. *Zoœcia* distant, very confusedly disposed, obscurely punctured round the border; the interspaces are sometimes irregularly cancellated; surface porcellanous. Primary *orifice* suborbicular or slightly coarctate; operculum suborbiculo-triangular. *Preoral rostrum* small, conical, obtuse, presenting on one side near the base a very minute avicularium, with a semielliptical mandible pointing upwards. Interspersed prominent *avicularia* with a short duckbill-shaped mandible and simple non-serrated beak; very rarely one of large size, completely immersed, with a long spatulate obtuse mandible very wide at the base.

Hab. Off Zamboanga, 10 fms.

In the figure the orifice is represented as notched on one side, but the apparent notch is merely caused by the projection of the base of the rostrum, and the rostral avicularium is represented larger than it should be.

5. C. ALBIROSTRIS, *Smitt.*†

Discopora albirostris (forma typica), *Smitt, Florid. Bryoz.* part ii. p. 70, pl. xii. figs. 234–239.

? Cellepora bispinata, *Bk. Brit. Mus. Cat.* p. 87, pl. cxx. figs. 1, 2.

Char. Zoarium massive, irregularly lobate, cristæform, erect or partially incrusting sponges or fucus. *Zoœcia* (marginal) barrel-shaped; surface pearly, smooth or finely granular; imperforate, or with a few punctures round the border. *Orifice* (primary) suborbicular, or arcuate; two long, very slender, unarticulated oral spines above. *Rostrum* (when fully formed) very long, straight and acuminate, solid, with a minute avicularium, with semi-

* "Chall. Rep." pl. xxx. fig. 7.

† "Chall. Rep." pl. xxxiii. fig. 7.

circular mandible on one side of the base, and overhanging a wide sinus; on the older zoœcia often a long, solid, upright acuminate spine, arising apparently from the side of the zoœcium about the middle of its length; the rostrum often developed into a very thick subcylindrical process, obliquely truncated at the end, and presenting on the oblique face a large avicularium with a blunt spatulate mandible and toothed beak (fig. 7*d*). A few interspersed immersed avicularia, usually placed transversely on the front of a zoœcium, and varying greatly in size; the mandible elongated, obtuse, or subspatulate, with a simple rounded beak.

Hab. St. 151. Off Heard Island, 75 fms., mud.

As Prof. Smitt remarks, the typical *C. albirostris* in a fresh condition is readily recognizable by its greyish-brown colour and blackish-brown opercula. The zoœcia, he goes on to observe, in the growing edge of the colony, are elongated ovate, presenting the greatest resemblance to *Cellepora bispinata*, B. M. Cat.

In this I quite agree with Prof. Smitt, and am strongly inclined to think that his *Cell. albirostris* is identical with my *C. bispinata.* Unfortunately I have no specimen of the latter to compare, and the figure and description in the Brit. Mus. Cat. are hardly sufficient to determine the point. Under these circumstances I have thought it best to retain Prof. Smitt's appellation. I would remark, however, that my term of "very minute," as applied to the usual kind of rostral avicularium, quite accords with that of *C. albirostris.* The large rostral avicularia are only occasional.

With respect to Prof. Smitt's supposition that *C. albirostris* and my *Cell. mamillata* may be connected, if I understand him correctly, I may observe that there can be no doubt of their complete distinctness. Nor can I see any reason for regarding the form described by Prof. Smitt, under the name of *C.* (*Discopora*) *pusilla*, as merely a variety of his *C. albirostris.* The two seem to me to be quite distinct; and how their close relation is "incontestably proved by the very same form of their zoœcial aperture," seems to me to be by no means clear, seeing that the form of aperture in question is one of very common occurrence.

6. C. TRIDENTICULATA, n. sp.*

Char. Zoarium lamellar, expanded, apparently unattached, uneven. *Zoœcia* deeply immersed; surface shining, granular,

* "Chall. Rep." pl. xxix. fig. 3.

imperforate. *Orifice arcuate or subtriangular*, with three (sometimes four) internal denticles within the lower border, about 0″·006–0″·007 wide. *Rostrum* (sometimes absent) a small rounded tuberosity, supporting on the summit, seated in a shallow depression, a minute avicularium with a semicircular mandible; a strong articulated spine on each side of the orifice. Large interspersed *avicularia* apparently vicarious (certainly not rostral), usually immersed, but sometimes more prominent, and partially erect, with a short, broad, duckbill-shaped mandible, shutting down into a shallow boat-like beak, the edge of which is finely pectinate.

Hab. St. 186. Lat. 10° 30′ S., long. 142° 18′ E.; 8 fms., coral-sand.

This well-marked species is at once recognizable by the long, articulated and indistinctly jointed oral spine on each side of the orifice. The limited development of the rostrum, with its little imbedded avicularium, is also a well-marked feature, as is also the fine pectination of the border of the cup in the interspersed avicularia. Another curious feature is the frequent occurrence on the surface of the zoarium of lengthened tubular processes or tunnels, looking like enormously elongated zoœcia. The nature of these curious appendages is very obscure.

7. C. COLUMNARIS, n. sp.*

Char. Zoarium expanded, thick, irregular in form and extent. *Zoœcia* very deeply immersed, ventricose, but with the outlines very obscure; substance of wall solid, porcellanous; surface finely granular. *Orifice* semicircular, lower lip straight and entire. A long, solid, tapering, columnar process springs from the back or side of the zoarium close to the orifice. In many zoœcia there is a small tubercular avicularian process in front below the orifice, which also sometimes rises in a columnar form; mandible triangular.

Hab. St. 162. Off East Moncœur Island, Bass Strait, 38–80 fms., sand.

8. C. HONOLULENSIS, n. sp.†

Char. Zoarium massive, irregular. *Zoœcia* very confusedly crowded, deeply immersed; surface finely granular, imperforate. *Orifice* (primary) semiorbicular or subtriangular, lower border

* "Chall. Rep." pl. xxix. fig. 11. † "Chall. Rep." pl. xxix. fig. 5.

straight, with a minute 3-toothed pectinate process within it. A short pointed preoral rostrum, supporting on one side a small avicularium, with a semicircular mandible. In the older parts very numerous, large, interspersed prominent avicularia, with lanceolate mandible pointing upwards, and simply channelled beak.

Hab. St. 260*. Off Honolulu, 18 fms.

Differs from *C. tridenticulata* in the much smaller size of the internal denticles, which rather resemble a minute 3-toothed comb, and in the almost universal presence, on the front of the older zoœcia, of a prominent avicularium with a lanceolate mandible and simply channelled non-serrated beak.

9. C. IMBELLIS.†

Char. Zoarium lamellar, flexuose, thin. *Zoœcia* distinct, erect, free above, ventricose and immersed below; surface finely pitted. *Orifice* arcuate, or subtriangular or suborbicular, about $0''{\cdot}006$ wide; peristome slightly thickened, a small avicularium in front just within the border. A few interspersed immersed avicularia, with an elongate spatulate mandible.

Hab. Off Bahia, 10–20 fms.

Only a single specimen, apparently old and dead.

10. C. RUDIS, n. sp.‡

Char. Zoarium (in a single specimen) consisting of a short, thick, cylindrical stem rising from a broad base and dividing into two rounded lobes. Aspect rugose and coarse. *Zoœcia* completely immersed and very confusedly heaped together. *Orifice* subquadrangular, large (nearly $0''{\cdot}01$ wide), depressed. *Preoral rostrum* in the ordinary zoœcia merely a tubercle supporting an oval *avicularium*, with a blunt elliptical mandible pointing downwards; in the fertile zoœcia the rostrum is developed into a broad hollow process, from which a raised border passes back on each side of the orifice to the sides of the oœcium. *Oœcium* deeply immersed, having on the front a crescentic disk, marked with radiating furrows. Very numerous interspersed immersed avicularia, lying in all positions, and of very various sizes, with a broad short mandible, much contracted at the base.

Hab. St. 320. Lat. 37° 17′ S., long. 53° 52′ W.; 600 fms., hard ground.

† "Chall. Rep." pl. xxix. fig. 10.

‡ "Chall. Rep." pl. xxviii. fig. 7. The operculum in *C. rudis* is pyriform; so that it really belongs to the next section.

11. C. SOLIDA, n. sp.

Char. Zoarium ramose or globate, very irregular; in the older portions the zoœcia are, as it were, all fused together, and coated with a porcellanous deposit, so that all trace of openings is lost. *Zoœcia* (younger) barrel-shaped, wide above. *Orifice* quadrangular, border entire; the zoœcium rises behind the mouth into an obtuse conical process, usually presenting a small *avicularium*, with a triangular mandible on the interior aspect. In front of the mouth is a much larger, rounded, tumid prominence, on which are, occasionally, placed a few very minute circular *avicularia*, also with an obtuse triangular mandible. Occasional large interspersed *avicularia*, with a broad, short, spatulate mandible.

Hab. St. 160. Lat. 42° 42′ S., long. 134° 10′ E.; 2600 fms., red clay.

The entire growth is solid and has a porcellanous aspect.

Section II.

12. C. SIMONENSIS, n. sp.*

Char. Zoarium branched or massive and irregular; surface uneven, nodulated, or papillose. *Zoœcia* deeply immersed and ventricose, with a row of punctures round the border, and sometimes sparsely punctured all over. *Orifice* clithridiate [keyhole-shaped]; peristome thick, in the older stage annular or shortly tubular. An obtuse avicularian process on one side close below the orifice, with a broadly triangular mandible pointing upwards. A few interspersed, minute, immersed avicularia with spatulate mandible.

Hab. St. 122. Lat. 9° 5′ S., long. 34° 49′ W.; 400 fms., mud. Simon's Bay.

The oral valve is of the same shape as the orifice, and has a pyriform thickening on each side †.

The small interspersed avicularia in the older parts of the zoarium appear to be transformed zoœcia of small size.

13. C. PUSTULATA, n. sp. ‡

Char. Zoarium cylindrical, irregularly branched; branches slightly tapering. *Zoœcia*, in the younger portions, distinct, ventricose; walls entire, uneven. *Orifice* clithridiate; peristome

* "Chall. Rep." pl. xxviii. fig. 6 & pl. xxix. fig. 9.

† "Chall. Rep." pl. xxix. fig. 9*a*.

‡ "Chall. Rep." pl. xxviii. fig. 8.

thin. In the older zoœcia a small tubercular preoral process, having on one side a minute *avicularium* with a subtriangular mandible. In the older portions the individual zoœcia are, for the most part, obliterated; and in those parts of the zoarium the surface presents small pustular, subhexagonal eminences, each of which has a minute *avicularium* in its centre. Besides these there are a few interspersed *avicularia* with spatulate mandible, with a very contracted base.

Hab. St. 167. Lat. 39° 32′ S., long. 171° 48′ E.; 150 fms., grey ooze. Off Marion Island, 50–75 fms.

14. C. CYLINDRIFORMIS, n. sp.*

Char. Zoarium conical or tapering. *Zoœcia* large, distinct. *Orifice* orbicular, widely emarginate. A strong, incurved, cylindrical preoral process, supporting a large *avicularium*, with a broad, equilateral, triangular mandible. Interspersed *avicularia* not numerous, having a broad, short, membranous mandible, either of a duck-bill form or squarely truncate. *Oœcium* small, erect, globose, punctured.

Hab. St. 142. Lat. 35° 4′ S., long. 18° 37′ E.; 150 fms., sand.

The only specimen is of a cylindrical form, about $\frac{3}{4}''$ long by $0''\cdot1$ in diameter, appearing, but not certainly, to be moulded on a worm-tube.

15. C. JACKSONIENSIS, n. sp.†

Char. Zoarium branched; branches compressed. *Zoœcia* barrel-shaped, very distinct at the growing edge, elsewhere confused; surface granular, with a row of small perforations round the border. *Preoral process* short, pointed, trifid, with an avicularium on one side at the base, with a rounded mandible. *Orifice* orbicular‡, widely notched in front. On some of the lateral zoœcia there is a strong projecting rostrum with a lanceolate avicularium, the beak of which is cupped and toothed.

Hab. St. 163 A. Off Port Jackson, 30–35 fms., rock.

16. C. EATONENSIS, n. sp.§

Char. Zoarium multiform, massive, or branched, the branches short, thick, and obtuse, or more or less lamellar, and free or incrusting, or parasitic, and more or less globose. *Zoœcia* (young) barrel-shaped, afterwards ventricose; surface entire, smooth.

* "Chall. Rep." pl. xxx. fig. 9.

† "Chall. Rep." pl. xxx. fig. 10.

‡ Not really notched.

§ "Chall. Rep." pl. xxix. figs. 4, 6, 8.

Orifice subarcuate, with a wide notch. *Preoral rostrum* very variable in size and conformation; small and conical, or very large and cylindrical towards the end, and deeply channelled on the posterior aspect, but always hollow; supporting near the extremity a small avicularium with a semicircular mandible; numerous, very large, interspersed avicularia, with a duckbill-shaped mandible, shutting down into a deeply cupped beak, the end of which is gouge-shaped and the border entire and sharp.

Hab. St. 149 D. Royal Sound, Kerguelen, 20–60 fms. St. 149 I. Off Christmas Harbour, 45–120 fms. St. 303. Lat. 45° 31′ S., long. 78° 9′ W.; 1325 fms., *Globigerina*-ooze. St. 315. Lat. 51° 40′ S., long. 57° 50′ W.; 5–12 fms., sand.

Though exhibiting great diversity, especially in the greater or less development of the rostrum, the specimens from the above localities agree in all essential particulars, such as the shape of the orifice and oral valve, the presence of the small rostral semicircular avicularium, which is sometimes terminal, sometimes seated below the summit, which may be prolonged into an acuminate point beyond it; but more particularly the peculiar conformation of the numerous and large interspersed avicularia.

At first I had divided the form into three species (*C. Eatonensis*, *C. magellensis*, and *C. rostrata*), but am now quite satisfied that they are all specifically identical.

17. C. OVALIS, n. sp.*

Char. Zoarium ramose, branches cylindrical, tapering. *Zoœcia* distinct, very prominent in the younger parts. *Orifice* orbicular, with a notch on one side. *Preoral process* strong, hollow, pointed, varying very much in height, and being much more prominent and pointed on the younger branches than on the main stem; it supports an *avicularium* with a wide triangular mandible; the beak simple. *Oœcia* subrecumbent, with two or three raised pores in front. Interspersed *avicularia* few, of an oval form.

Hab. St. 75. Lat. 38° 37′ N., long. 28° 30′ W.; 450 fms., sand. Parasitic on a bundle of radical fibres of a Sertularian.

The labial notch in this case resembles that which occurs in most of the Retepores; it is not median, but placed to one side, and appears, as in Retepores, to have a tendency to become converted into a suboral pore.

* "Chall. Rep." pl. xxviii. fig. 5. *C. ovalis* really belongs to the Holostomatous division.

18. C. POLYMORPHA, n. sp.†

Char. *Zoarium* irregularly branched; branches tapering, short. *Zoœcia* very confusedly disposed; surface coarsely granular. *Orifice* (primary) circular, widely emarginate; afterwards the peristome becomes much thickened and raised so as to conceal the primary mouth. Three or four acute curved denticles within the peristome, which, in this stage, is unarmed. In other *zoœcia* the labial sinus becomes fissured, and eventually converted more or less completely into a suboral pore, whilst in front the peristome forms a prominent tubercular eminence, supporting on the side overlooking the fissure a large *avicularium*, with a blunt triangular mandible and toothed beak. A few interspersed *avicularia* on low horizontal eminences, with a spatulate mandible (often truncated) and bifid beak. *Oœcia* erect or subrecumbent, globose; surface finely granular.

Hab. St. 260*. Off Honolulu, 20-40 fms.

18*a*. Var. *a*. DISCOIDEA.‡

Char. *Zoarium* (in single specimen) discoid, unilamellar, attached only at the centre. *Zoœcia* at the growing edge ventricose, surface granular, entire; primary orifice suborbicular or elliptical, with a minute three-toothed process within the lower border. This latter is gradually developed into a large preoral rostrum placed to one side, at the base of which is a small labial sinus, and on the posterior face a large avicularium with a duck-bill-shaped mandible and toothed beak, beyond which, in the older zoœcia, the *rostrum* is produced in the form of a strong conical solid spine. A few interspersed recumbent subimmersed avicularia, with a long lanceolate mandible and non-serrated beak.

Hab. St. 186. Lat. 10° 30′ S., long. 142° 18′ E., 8 fms.

19. C. TUBERCULATA, n. sp.§

Char. *Zoarium* massive, tuberculated. *Zoœcia* erect, in groups of several together. *Orifice* arcuate or subquadrangular, slightly notched or sinuated below; peristome thick. *Preoral rostrum* very short, conical, with a minute avicularium near the summit. A few large interspersed *avicularia* on elevated hollow processes, with a broad, spear-shaped, obtuse mandible, which does not shut down within the beak.

Hab. Port Jackson, 2–10 fms.

† "Chall. Rep." pl. xxx. fig. 11.

‡ "Chall. Rep." pl. xxx. fig. 8.

§ "Chall. Rep." pl. xxviii. fig. 9.

As only a single, small, rather worn specimen was in the collection, the distinctness of this species must be regarded as doubtful.

20. C. VAGANS, n. sp.†

Char. Zoarium incrusting, dark olive-colour. *Zoœcia* small, with a single row of puncta round the border. Surface granular. *Primary orifice* orbicular or subclithridiate. The peristome much produced in front, with a wide sinus; afterwards rising into a hollow conical-pointed rostrum, which usually supports on one side a minute avicularium with a semicircular mandible. Numerous large interspersed avicularia, whose mandible expands at the extremity into three or four branches, connected by a delicate membranous expansion, capable of being spread over foreign bodies; sometimes pointed, but always more or less membranous towards the end.

Hab. St. 148. Lat. 46° 47′ S., long. 51° 37′ E., 210 fms. St. 260*. Off Honolulu, lat. 21° 11′ N., long. 157° 25′ W., 310 fms.

The peculiarities of this species are:—

1. The almost tubular production of the peristome, even in the youngest zoœcia seen. 2. The peculiar conical-pointed form of the preoral rostrum, which sometimes represents merely an obtuse tubercle, but is more commonly of an acute conical shape, the apical portion of which, being denuded of the dark fuscous epidermis, appears of an ivory whiteness, with a finely granular surface and porcellanous aspect.

The mode in which the partially membranous mandible of the larger avicularia sometimes spreads like a webbed hand over foreign bodies is very curious. In colour and superficial aspect this form might be confounded with *C. mamillata*, but they are quite distinct.

Section III.

21. C. BICORNIS, n. sp.‡

Char. Zoarium globose. *Zoœcia* ventricose below, becoming tubular above. *Orifice* circular, notched; peristome much raised, tubular, and furnished in the perfect sterile zoœcia with two cylindrical preoral processes, having on their summits minute *avicularia*, with an acute triangular mandible; besides these pro-

† "Chall. Rep." pl. xxix. fig. 10. ‡ "Chall. Rep." pl. xxx. figs. 1 & 12.

cesses the peristome supports 2–4 spines, which in the perfect zoœcia are replaced by a recumbent globular oœcium, having a rounded fissure in front; the surface otherwise of the oœcium is smooth and polished. A very few interspersed *avicularia*, with an excessively delicate membranous mandible of a broadly lanceolate form.

Hab. Prince Edward's Island, 80–150 fms.; parasitic on *Myriozoum truncatum*. And St. 150, lat. 52° 4′ S., long. 71° 22′ E., 150 fms., on *Onchopora Sinclairei*.

22. C. BILABIATA, n. sp.*

Char. *Zoarium* pisiform, very minute. *Zoœcia* very irregularly disposed, erect, pitcher-shaped. *Orifice* circular, emarginate; peristome thick and often produced into a rather deep bilabiate cup. On some zoœcia a short, strong, conical preoral process. *Oœcia* small, spherical, recumbent.

Hab. St. 161. Off Port Philip, 38 fms., sand. St. 135. Off Tristan d'Acunha, 60–1100 fms., rock. Parasitic on *Amathea spiralis*.

The collection affords only one or two small specimens.

23. C. SIGNATA, n. sp.†

Char. *Zoarium* pisiform. *Zoœcia* deeply immersed and very confusedly arranged; surface smooth, shining. *Orifice* arcuate, with a straight lower lip, having a very minute median notch. A strong, curved, hollow, preoral rostrum, with an *avicularium* on its posterior aspect near the summit, with a short, obtuse spatulate mandible pointing upwards. A few large interspersed *avicularia* with broad spatulate mandible. *Oœcia* erect, flattened in front, on which is a semicircular area, punctured (not grooved) round the border.

Hab. St. 304. Lat. 46° 53′ S., long. 75° 11′ W.; 45 fms., sand. Parasitic on a Sertularian.

24. C. CONICA, n. sp.‡

Char. *Zoarium* forming small conical growths, disposed several together in a stelliform manner (parasitic on a Sertularian). *Zoœcia*, surface rugose, obscurely punctured when very young. *Orifice* clithridiate; peristome thick, sometimes raised into a ridge on one or both sides. *Preoral rostrum* cylindrical, short,

* "Chall. Rep." pl. xxx. fig. 2.

† "Chall. Rep." pl. xxx. fig. 3.

‡ "Chall. Rep." pl. xxviii. fig. 10. Subsequent observation renders it probable that the form here described represents the young condition of a large branched and lobate form, which also occurs in S. Africa, but is not in the 'Challenger' collection.

curved, with an avicularium on the summit. Interspersed avicularia few in number, of small size, with a spatulate mandible. *Oœcium* small, spherical, deeply immersed, punctured in front.

Hab. Simon's Bay.

25. C. ANSATA, n. sp.*

Char. Zoarium in the form of small stellate growths or tufts, having three or four conical-pointed divisions. *Zoœcia* deeply immersed at the base, but more free and erect above; surface shining, rugose. *Orifice* circular, notched; peristome, in the older zoœcia, produced in front and on the sides into a long tubular or rather canalicular process, which supports on each side a small *avicularium* with a semicircular mandible. Numerous interspersed *avicularia* with curved, spatulate, thin, membranous mandible.

Hab. St. 75. Lat. 38° 37′ N., long. 28° 30′ W.; 450 fms., sand. Parasitic on a small Sertularian.

26. C. CANALICULATA, n. sp.†

Char. Zoarium pisiform. *Zoœcia* ventricose, tolerably distinct; surface rough, entire. *Orifice* orbicular and notched in front, or more usually clithridiate. A strong curved preoral *rostrum*, from which a thin expansion is continued on each side of the orifice so as to form a spacious spout-like cavity, at the bottom of which the mouth is situated. On the posterior aspect of the process, near the summit, is an *avicularium* with a semicircular mandible; the apical portion of the process is cylindrical.

Hab. St. 48. Lat. 43° 2′ N., long. 64° 2′ W.; 51 fms., rock.

27. C. BIDENTICULATA, n. sp.‡

Char. Zoarium small, pisiform. *Zoœcia* ventricose; walls thin, sparsely punctured. *Orifice* subclithridiate, with two very minute denticles within the lower border; peristome, in the older zoœcia, raised on one side into a thin canalicular expansion, and on the other side into a thicker process, which supports, on its inner face, a rather large *avicularium*, with a triangular obtuse mandible.

Hab. St. 163 A. Off Port Jackson, 30–35 fms., rock. Parasitic on a Sertularian.

* "Chall. Rep." pl. xxviii. fig. 5.

† "Chall. Rep." pl. xxx. fig. 5.

‡ "Chall. Rep." pl. xxx. fig. 6.

Supplementary Note respecting the Use to be made of the Chitinous Organs in the Cheilostomata in the Diagnosis of Species, and more particularly in the Genus *Cellepora.*

(PLATES XXVI. & XXVII.)

I MUCH regret that before drawing up the preceding account my attention had not been called to a suggestion by Mr. Arthur W. Waters* respecting the use of the characters afforded by the *oral valve* or *operculum* in the diagnosis of species in the Cheilostomatous Polyzoa, as I should otherwise have been saved a great amount of time and trouble in the endeavour to establish satisfactory distinctive characters in the perplexing and difficult group of the Cellepores.

But having since devoted much attention to this point, and examined the characters, not only of the *operculum*, as suggested by Mr. Waters, but also, in addition, those of the other chitinous elements of the skeleton in between sixty and seventy species of *Celleporæ*, as well as in numerous species of *Reteporæ* and *Salicornariadæ*, both groups in which the determination of species is often attended with considerable difficulty and uncertainty, I have become convinced that the characters derived from the chitinous organs will be found of the greatest possible utility, and at the same time capable of being employed with the utmost facility and precision.

In fact, so far as my present experience teaches, it appears to me that the characters derived from these parts of the skeleton will prove, at any rate in the three generic groups above mentioned, almost alone sufficient to determine specific distinction or affinity, so that from a very minute fragment of a zoarium, if in the proper state of preservation, the species may, in a few minutes, be made out with the utmost ease.

How far the characters of these appendages may be of use with respect to generic or more general distinction, I am not at present prepared to say, and much doubt whether they will be found extensively useful in that regard.

But at present I am convinced that in future it will be indispensably requisite in the definition of a species, at any rate in certain defined natural groups, to give the characters of the chitinous organs, which are certainly of equal, if not greater, value than those afforded by the calcareous skeleton alone.

* "On Bryozoa," Proc. Literary & Philos. Soc. Manchester, 1878, vol. xvii. p. 125.

It is therefore very unfortunate that the facile, and comparatively more certain, means of diagnosis derived from these parts should not be available in the case of fossil or even of recent forms in which nothing remains except the calcareous frame.

So far as my present limited experience shows, the characters of the chitinous organs, except in size, appear, within the limits of the same species, to be remarkably constant; and if, as in some cases, it happens that some apparent diversity of form (as regards the operculum more especially) exists, it will be found that these diversities may be reduced to the same fundamental type through gradations from one extreme to the other. But in by far the greater number of cases the variability in these parts seems to be far less than in any other parts of the skeleton. And as the form of the *operculum*, though of course usually more or less correspondent to that of the *orifice*, is much less liable to vary or to be concealed or altered by age and hypertrophy of the surrounding parts, it is a character, where obtainable, of greater utility and certainty than that of the *orifice* itself, upon which later systematists have very properly laid so much stress. But though an important character, and one that should always be noted, the mere form or even garniture of the *orifice* seems to me to be one of a subordinate kind; and the attempt to found generic distinctions mainly upon such a single character as the form of the *orifice* alone, must, as in all cases where one or two isolated characters are taken, inevitably lead to confusion from the numerous exceptions that will have to be admitted.

It is for this reason, also, that in the more restricted field of specific distinction it will not do to rely simply on the characters of the *operculum* alone, which, though usually definite enough, must, in many cases, be very carefully scrutinized, and sometimes cannot be discriminated without great difficulty, and sometimes even but very doubtfully at all. But if the characters of the *operculum* are taken in conjunction with those of the other chitinous elements where such exist, the chances that the combined characters of all these parts will coincide in any two really distinct species are extremely remote, if not altogether impossible.

In the genera above noticed this coincidence is even still less likely to occur, since in the majority of species in them there are usually at least two kinds of *avicularia,* and sometimes even three or four; and that similar avicularian mandibles should be found associated with similar *opercula* appears to be hardly credible.

I am not, however, prepared to assert that this is impossible,

since I am acquainted with more than one instance among the Cellepores in which, so far as the general external characters are concerned, the species would seem to be quite distinct, but in which, nevertheless, the characters of the chitinous appendages are so exactly alike that one is compelled to regard them as specifically identical.

In the two accompanying Plates I have given figures of the chitinous elements of a good many of the species enumerated in the foregoing paper, together with those of some other species not included in the 'Challenger' collection, with the view of

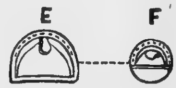
(1) facilitating the diagnosis of the species figured, and

(2) of showing the mode in which, as it seems to me, this means of diagnosis may be employed.

The chitinous elements of the skeleton in the Cheilostomatous Polyzoa consist mainly of the *operculum* or *oral valve* and the movable limb or *mandible* of the various kinds of avicularian and vibracular organs, besides some others of very limited occurrence.

In all the *Celleporæ* we find, besides the *operculum*, one, and usually two or more kinds of *avicularia*. One of these, which invariably exists, is generally of small size, with a more or less semicircular or subtriangular mandible, and placed in close proximity to the border of the orifice, and very frequently on a preoral rostral process or on other elevated processes, or sessile on some part of the peristome. This kind of *avicularium* I have termed the *oral* (woodcut, E & F), and the small peculiar mandible belonging to it will always be readily distinguished. But besides these we almost universally find other avicularian organs of larger size and variously disposed upon or interspersed among the *zoœcia*. These are most frequently seated upon special adventitious processes on a *zoœcium*, whence they may be termed *adventitious*; or may occupy the place of an aborted or transformed zoœcium irregularly intercalated among the others, to which kind of avicularium the term *vicarious* may be applied.

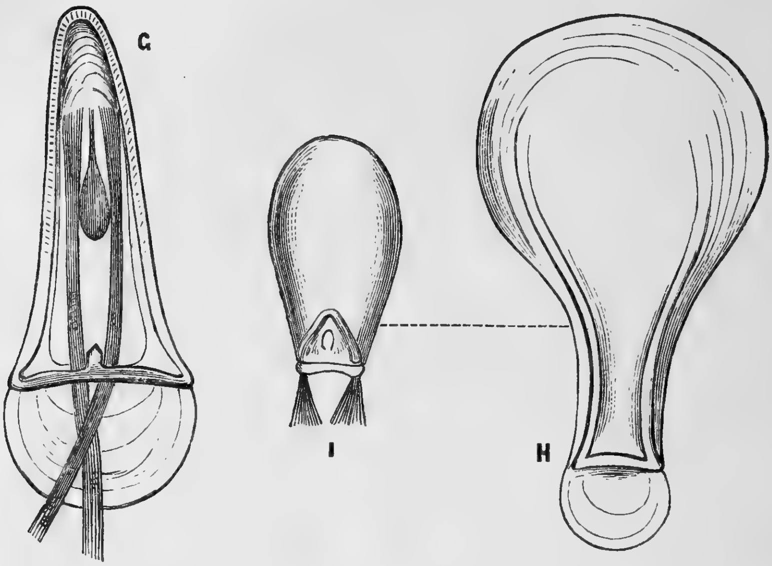
E F



These interspersed avicularia of both kinds present the greatest diversity of conformation, and consequently their chitinous mandibular limbs afford the most important differential characters.

This is not the place to enter upon a general survey of the multiform avicularian organs in the Cheilostomata, though this is one of the most important subjects in relation to classification; and I would here merely observe that in *Cellepora* these organs

may be divided, as regards their presumed function, into the *prehensile* (woodcut, G) and the *retentive* (woodcut, I & H). The



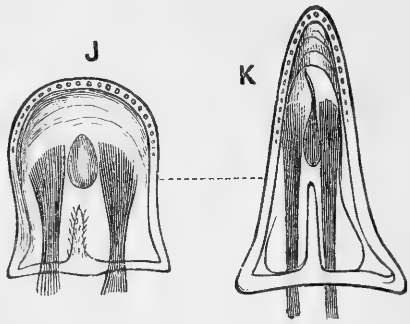
former, from the strength and conformation of the *mandible* and the corresponding *beak*, which is not unfrequently toothed or serrate, as well as from the powerful muscles by which the mandible is moved, are evidently fitted to close down upon living prey of some kind; whilst the latter, having a more or less membranous or extremely delicate mandible, forming, as it were, when closed the lid of a cup-like cavity or receptacle, seem to be adapted for the purpose of simply retaining passive objects; and corresponding with this less active function, the musculature and chitinous framework of the mandible are very much less developed.

There are many points connected with these organs deserving of close study, and numerous variations, sometimes of a minute character, though from their constancy no doubt important, which demand close attention in comparing different mandibles. Among these points may be mentioned the size, form, and position of the foramen which exists in all the prehensile avicularia, and the points of insertion of the occlusor muscles, &c. Amongst other minute and apparently unimportant characters of this kind, I may mention one which appears, from its constancy, somewhat curious, and may perhaps prove to be of some classificatory value.

In many of the species of *Cellepora* belonging to what I have termed the "holostomatous" section, in all the *prehensile* avicularian mandibles (amongst which are included the *oral*) a minute slender projection or tongue may be seen rising from

the middle of the transverse bar forming the base of the mandible. In one or two instances I have fancied that this little projection was beset with short upright *setæ*; but I am by no means sure of this observation, as I have almost universally failed to perceive any thing of the kind. But should it be found in recent specimens, and under very favourable circumstances, that this *languette* is so furnished, one might suppose that it formed a sort of tactile organ, the touching of which might induce the sudden closure of the mandible. It might thus, though differently placed, be taken to represent the apparently tactile organ long ago noticed in some other avicularia (see woodcuts J & K). But a curious point connected with this little appendage is, that it is not found in any of the "schizostomatous" Cellepores, so far as my observation goes, but seems to be limited to the holostomatous species belonging to the southern hemisphere alone.

J K



It remains to say a few words on the method I have found most convenient for the procuring of the chitinous elements for the purpose of examination. It is, however, extremely simple and easy, consisting merely in the removal of the calcareous matter from the fragment or specimen to be examined, by immersion for a short time in dilute nitric acid, and, after it has been washed with as little disturbance as possible, staining the flocculent residue with picro-carmine. It should then be *teased* to pieces in a drop of glycerine or gum and glycerine &c. and examined under a covering-glass. All the chitinous parts will, in this way, be displayed of a bright yellow colour.

This mode of preparation, moreover, has the advantage of displaying in great perfection nearly all the soft animal tissues, if any such exist in the specimen, however long it may have been dried. The muscular tissue is especially well displayed in this way, in specimens that have been dried for thirty or forty years, in almost as great perfection as if the specimen had been living; and I have little doubt that any one versed in the modern methods of histological research will be able to make out in specimens of almost any age, if originally in proper condition, and especially if they had been killed by immersion in spirit, almost as much as could be found in a perfectly fresh subject. In one instance, in a

specimen of *Cellepora fusca* from the 'Rattlesnake' collection and thirty or forty years old, I detected several minute tailed corpuscles, which can scarcely be any thing else than spermatozoa (see Plate XXVI. fig. 11).

EXPLANATION OF THE PLATES.

Each square or division contains the chitinous appendages of a single species. All the figures are magnified 115 diameters, and a scale =0·01 millim. is added.

Plate XXVI.

Fig. 1. *Cellepora albirostris*, mihi.
2. *C. albirostris?* (Bass Strait, Mr. Hincks.)
3. *C. hastigera.*
4. *C. columnaris.*
5. *C. polymorpha*, the massive branched form.

Fig. 6. *C. polymorpha*, var. *discoidea.*
7. *C. Jacksoniensis.*
8. *C. apiculata.*
9. *C. tridenticulata.*
10. *C. nodulosa.*
11. *C. fusca.*
12. *C. zamboangensis.*

Plate XXVII.

Fig. 1. *Cellepora ansata.*
2. *C. Eatonensis*, massive form. St. 149 D.
3. —— ——, incrusting form. St. 149 I.
4. *C. bicornis.*
5. *C. Eatonensis*, var. *magellanica.*

Fig. 6. *C. Eatonensis.*
7. *C. canaliculata.*
8. *C. bidenticulata.*
8*a*. —— —— (young).
9. *C. conica.*
10. *C. perlacea* (MS.).
11. *C. simonensis.*
12. *C. rudis.*

Observations on Ants, Bees, and Wasps.—Part VIII. By Sir John Lubbock, Bart., Pres. Linn. Soc., M.P., F.R.S., D.C.L., LL.D.

[Read June 2, 1881.]

Experiments with Light of different Wave-lengths.

In one of my former papers (Linnean Journ. vol. xiv. p. 278) I have given a series of experiments made on ants with light of different colors, in order, if possible, to determine whether ants have the power of distinguishing colors. For this purpose I utilized the dislike which ants, when in their nest, have for light. Not unnaturally, if a nest is uncovered, they think they are being attacked, and hasten to carry their young away to a darker and, as they suppose, a safer place. I satisfied myself, by hundreds of experiments, that if I exposed to light the greater part of a nest, but left any of it covered over, the young would certainly be con-

veyed to the dark part. In this manner I satisfied myself that the various rays of the spectrum act on them in a different manner from that in which they affect us; for instance, that ants are specially sensitive to the violet rays.

But I was anxious to go beyond this, and to attempt to determine how far their limits of vision are the same as ours. We all know that if a ray of white light is passed through a prism, it is broken up into a beautiful band of colors—the spectrum. To our eyes this spectrum is bounded by red at the one end and violet at the other, the edge being sharply marked at the red end, but less abruptly at the violet. But a ray of light contains, besides the rays visible to our eyes, others which are called, though not with absolute correctness, heat-rays and chemical rays. These, so far from falling within the limits of our vision, extend far beyond it, the heat-rays at the red, the chemical rays at the violet end.

I had already tried various experiments with spectra derived from sunlight; but, owing to the movement of the earth, they were not thoroughly satisfactory. Mr. Spottiswoode was also good enough to enable me to make some experiments with electric light, which have been already recorded; and I have now to bring before the Society some additional and much more complete experiments, which, through the kindness of Prof. Dewar, Prof. Tyndall, and the Board of Managers, to whom I beg to offer my most cordial thanks, I have been enabled to make in the Laboratory of the Royal Institution.

Prof. Dewar was also kind enough to test my glasses and solutions with reference to their power of transmitting color. Taking the wave-length of the extreme visible red as 760 and that of the extreme violet as 397, we have

760	to	647	give	red.
647	,,	585	,,	orange.
585	,,	575	,,	yellow.
575	,,	497	,,	green.
497	,,	455	,,	blue.
445	,,	397	,,	violet.

The result of his examination of my glasses and solutions was as follows:—

The light-yellow glass cut off the high end down to wave-length 442.

The dark-yellow glass cut off the high end down to wave-length 493.

The green glass cut off the high end down to wave-length 465, and also the red to 616.

The red glass cut off the high end down to wave-length 582.

The violet glass cut off the orange and yellow from wave-length 684 to 583, and a band between wave-lengths 543 and 516.

The purple glass cut off the high end down to wave-length 528.

The solution of chromate of potash cut off the high end to 507.

The saffron cut off the high end to about 473.

Blue fluid cut off the low end to 516.

Red fluid cut off the high end to 596.

In my previous experiments with colored spectra, the ants carried the pupæ out of the portion of the nest on which coloured light was thrown and deposited them against the wall of the nest; or, if I arranged a nest of *Formica fusca* so that it was entirely in the light, they carried them to one side or into one corner. It seemed to me, therefore, that it would be interesting so to arrange matters, that on quitting the spectrum, after passing through a dark space, the ants should encounter not a solid obstacle, but a barrier of light. With this object, I prepared some nests 12 inches long by 6 inches wide; and Mr. Cottrell kindly arranged for me at the Royal Institution on the 29th of June, by means of the electric light, two spectra, which were thrown by two glass prisms on to a table at an angle of about 45°. Each occupied about 6 inches square, and there was a space of about 2 inches between the red end of the one and the violet of the other, the more distant spectrum being a good deal the brightest.

Exp. 1.—In the light space I placed a nest of *Formica fusca*, 12 inches by 6, containing about 150 pupæ, and arranged it so that one end was distinctly beyond the limit of the violet visible to us, and all but to the edge of the green given by thalline paper*, and the other just beyond the visible red. The pupæ at first were almost all in or beyond the violet, but were carried into the dark space between the two spectra, the bright thalline band being avoided, but some pupæ being deposited in the red.

Exp. 2.—I then tried the same experiment with a nest of *Lasius niger*, in which there were many larvæ as well as pupæ. They were all at the commencement at the blue end of the nearer spectrum.

* If paper steeped in thalline is placed in the ultra-violet portion of the spectrum, it gives, with rays of a certain wave-length, a distinctly visible green colour, which therefore constitutes a green band.

The larvæ were left by themselves in the violet, while pupæ were ranged from the end of the green to that of the red inclusive.

Exp. 3.—Arranged a nest of *L. niger* as before; at the commencement the pupæ and larvæ were much scattered, being, however, less numerous in the violet and ultra-violet rays. Those in the ultra-violet rays were moved first, and were deposited, the larvæ in the violet, and the pupæ in the red.

Exp. 4.—Made the same experiment with another nest of *L. niger*. At the commencement the larvæ and pupæ were in the violet and ultra-violet portion, extending to double the distance from the visible end to the thalline band. The ants soon began bringing the pupæ to the red. Over part of the red I placed a piece of money. The pupæ were cleared from the ultra-violet first. That the pupæ were not put in the red for the sake of the red light was evident, because the space under the coin was even more crowded. The pupæ were heaped up in the dark as far as the thalline-band of the other spectrum. I then brought the second spectrum nearer to the first. The pupæ which thus found themselves in the thalline band were gradually moved into the dark.

Exp. 5.—Tried the same with another nest of *L. niger*. The pupæ were at first in the violet and ultra-violet about double as far as the thalline line, while most of the larvæ were in the green. The experiment began at 1.15. The furthest part was cleared first; and they were again brought principally into the yellow, red, and dark.

Again, I arranged them pretty equally from double the distance of the thalline from the violet as far as the blue of the other spectrum, most, however, being in the violet and blue and a few scattered all over.

The pupæ in the red were not moved. The others were carried beyond the thalline band into the yellow or red.

Exp. 6.—Repeated the same experiment. Begun it 11.15. Placed some pupæ in the red, some in the yellow, and a few scattered over the second spectrum; there were none in the nearer one.

They were all carried away from the red past the violet, and put down in the dark portion, or in the red and yellow, of the nearer spectrum.

These experiments surprised me much at the time, as I had expected the pupæ to be carried into the space between the two

spectra; but it afterwards occurred to me that the ultra-violet rays probably extended further than I had supposed, so that even the part which lay beyond the thalline band contained enough rays to appear light to the ants. Hence perhaps they selected the red and yellow as a lesser evil.

Exp. 7.—I altered, therefore, the arrangement. Prof. Dewar very kindly prepared for me a condensed pure spectrum (showing the metallic lines) with a Siemens's machine, using glass lenses and a mirror to give a perpendicular incidence when thrown on the nest. I arranged the pupæ again in the ultra-violet as far as the edge of the fluorescent light shown with thalline paper. The pupæ were all again removed, and most of them placed just beyond the red, but none in the red or yellow.

Exp. 8.—Arranged the light as before, and placed the pupæ in the ultra-violet rays. In half an hour they were all cleared away and carried into the dark space beyond the red. We then turned the nest round and placed the part occupied by the pupæ again in the violet and ultra-violet. The light chanced to be so arranged that along one side of the nest was a line of shadow; and into this the pupæ were carried, all those in the ultra-violet being moved. We then shifted the nest a little, so that the violet and ultra-violet fell on some of the pupæ. These were then all carried into the dark, the ones in the ultra-violet being moved first.

It is noticeable that in these experiments with the vertical incidence there was less diffused light, and the pupæ were in no case carried into the red or yellow.

Exp. 9.—I arranged the light and the ants as before, placing the pupæ in the ultra-violet, some being distinctly beyond the bright thalline band. The ants at once began to remove them. At first many were deposited in the violet, some, however, being at once carried into the dark beyond the red. When all had been removed from the ultra-violet, they directed their attention to those in the violet, some being carried, as before, into the dark, some into the red and yellow. Again, when those in the violet had all been removed, they began on the pupæ in the red and yellow, and carried them also into the dark. This took nearly half an hour. As I had arranged the pupæ, and it might be said that they were awkwardly placed, we then turned the nest round, leaving the pupæ otherwise as they had been arranged by the ants; but the result of moving the nest was to bring some of them into the violet, though most were in the ultra-violet; while beyond them

was a space of about an inch, which, in Prof. Dewar's opinion, was beyond the limit of the transparency of glass to the ultra-violet rays, and would therefore be as free from rays as the part beyond the red. They were, as before, all carried into the dark space beyond the red in about half an hour.

We then turned the glass round again, this time arranging the end about the length of the spectrum beyond the end of the violet visible to our eyes. They began clearing the thalline band, carrying some into the violet, but the majority away further from the spectrum. In a quarter of an hour the thalline band had been quite cleared; and in half an hour a band beyond, and equal to the thalline band, those in the violet being left untouched. After the pupæ in the ultra-violet portion had all been moved, those in the violet were also carried away and deposited about twice as far from the edge of the violet as the width of the bright thalline band.

Exp. 10.—Experimented again with the same arrangement as before, using another nest of *Lasius niger* and placing the pupæ in the violet and a little beyond. The ants at once began removing them into the dark, tunnelling into the heap, and then carrying away those in the ultra-violet first, although they were further off. In half an hour they had all been moved out of the violet and ultra-violet, about half being in the dark, and half having been provisionally placed in the red and yellow.

Exp. 11.—Same arrangement as before. The pupæ being placed all along one side of the nest, from the edge of the red to a distance beyond the violet as great as the whole length of the spectrum. I began at 4.15. By degrees they were all cleared away from the spectrum, except those in the violet, where indeed, and immediately outside of which, the others were placed. At 5, however, they began to carry them back into the red. At 5.45 the blue and violet were nearly cleared, the pupæ being placed in the red and yellow. At 6.15 they had all been brought from the violet and ultra-violet into the red and yellow.

I then shook up the pupæ so that they were arranged all along one side of the nest, and extended about an inch beyond the red. This excited them very much, and in less than ten minutes all those in the spectrum, and for about 6 inches beyond the violet, were moved, but at first put down anywhere, so that they were scattered all over the nest. This, however, lasted for a very short time, and they were all carried into the dark beyond the red or

into the extreme end beyond the violet. At 7 they followed the line of the red at one end, coming about $\frac{1}{4}$ inch within it, which was not owing to want of room, as one side of the nest was almost unoccupied; at the other end they were all carried 3 inches beyond the end of the violet.

I then arranged the same ants in a wooden frame consisting of a base and two side walls, between which in the middle was a perpendicular sliding door. The pupæ had been arranged by the ants in the centre of the nest, so that some were on each side of the door. We then, by means of a strong induction-coil, threw a magnesium-spark on the nest from one side, and the light from a sodium-flame in a Bunsen burner on the other, the light being in each case stopped by the door, which was pressed close down on the nest. In this way the first half was illuminated by the one light, the second by the other, the apparatus being so arranged that the lights were equal to our eyes—that, however, given by the magnesium, consisting mainly of blue, violet, and ultra-violet rays, that of the sodium being very yellow and poor in chemical rays. In a quarter of an hour the pupæ were all carried into the yellow. The sodium light being the hotter of the two, to eliminate the action of heat I introduced a water-cell between the ants and the sodium-flame, and made the two sides as nearly as possible equally light to my eye. The pupæ, however, were again carried into the sodium side.

I repeated the same experiment as before, getting the magnesium-spark and the sodium-flame to the same degree of intensity, as nearly as my eye could judge, and interposing a water-screen between the sodium-flame and the ants. The temperature was tested by the thermometer; but I could distinguish no difference between the two sides. Still the ants preferred the sodium side. This I repeated twice. I then removed the magnesium-spark somewhat, so that the illumination on that side was very much fainter than on the other; still the pupæ were carried into the sodium-light. I then turned the nest round so as to bring them back into the magnesium. They were again carried to the sodium side.

Once more I repeated the same experiment. The light on the magnesium side was so faint that I could scarcely see the pupæ, those on the sodium side being quite plain. The thermometer showed no difference between the two sides. The pupæ were carried into the sodium-light. I then turned the nest round

twice; but the pupæ were each time carried out of the magnesium-light.

These experiments seemed strongly to indicate, if not to prove, that ants were really sensitive to the ultra-violet rays. Now to these rays sulphate of quinine and bisulphide of carbon are extremely opaque, though perfectly transparent in the case of visible rays, and therefore to our eyes entirely colourless and transparent. If, therefore, the ants were really affected by the ultra-violet rays, then a cell containing a layer of sulphate of quinine or bisulphide of carbon would tend to darken the underlying space to their eyes, though to ours it would not do so. It will be remembered that if an opaque substance is placed over a part of a glass nest, other things being equal, the ants always congregate under it; and that if substances of different opacity are placed on different parts of a nest, they collect under that which seems to them most opaque.

Over one of my nests of *Formica fusca*, therefore, I placed two pieces of dark-violet glass 4 inches by 2 inches; and over one of them I placed a cell containing a layer of bisulphide of carbon, an inch thick, slightly coloured with iodine. In all these experiments, when I moved the liquids or glasses, I gave the advantage, if any, to the one under which experience showed that the ants were least likely to congregate. The ants all collected under the glass over which was the bisulphide of carbon.

I then thought that though no doubt the iodine rendered the bisulphide more completely impervious to the ultra-violet rays, I would try the effect of it when pure and perfectly colourless. I therefore tried the same experiment with pure bisulphide, moving the two glasses from time to time in such a manner that the ants had to pass the first violet glass in order to reach that over which was the bisulphide.

At 8.30	the ants were all under the glass over which was the bisulphide of carbon: I then changed the position.		
8.45	ditto	ditto	ditto.
9	ditto	ditto	ditto.
9.15	ditto	ditto	ditto.

Although the bisulphide of carbon is so perfectly transparent, I then thought I would try it without the violet glass. I therefore covered part of the nest with violet glass, a part with a layer

of bisulphide of carbon, moving them from time to time as before.

At 9.45 the ants were all under the bisulphide: I then changed the position.

10.15	ditto	ditto	ditto.
10.45	ditto	ditto	ditto.
11.15	ditto	ditto	ditto.

I then reduced the thickness of the layer of bisulphide to $\frac{4}{10}$ of an inch.

At 1.30 the ants were all under the bisulphide: I then changed the position.

2	ditto	ditto	ditto.
2.30	ditto	ditto	ditto.
3	ditto	ditto	ditto.

Then thinking that possibly it might make a difference, the one shelter being a plate of glass and the other a liquid, I tried two similar bottles, one containing water and the other bisulphide of carbon; but in every case the ants went under the bisulphide of carbon. On the other hand, when I used a solution of ammonio-sulphate of copper so deep in colour that the ants were only just visible through it, the ants went under the coloured liquid.

Oct. 10. I uncovered the nest at 7 A.M., giving the ants an option between the bisulphide and a solution of ammonio-sulphate of copper.

At 7.30 the ants were all under the solution of ammonio-sulphate of copper. Changed the places.

8	ditto	ditto	ditto.
8.15	ditto	ditto	ditto.

I then replaced the solution of sulphate of copper by one of carmine so deep that the ants could only just be seen through it.

At 8.30 they were under the carmine. I shifted the carmine and bisulphide.

8.45	ditto	ditto	ditto.
9	ditto	ditto	ditto.
9.15	ditto	ditto	ditto.
9.30	ditto	ditto	ditto.

I now took a bright-green solution of chlorate of copper:—

At 10	they were under the chlorate of copper. I shifted the liquids.		
10.15	ditto	ditto	ditto.
12.30	ditto	ditto	ditto.
12.45	ditto	ditto	ditta.

Subsequently I used saffron instead of the chlorate of copper:—

At 11	they were under the saffron.	I shifted the liquids.	
11.15	ditto	ditto	ditto.
11.25	ditto	ditto	ditto.
11.35	ditto	ditto	ditto.

I now took successively red, yellow, and green glass; but in every case the ants preferred the glass to the bisulphide. Although, therefore, it would seem from the previous experiments that the bisulphide darkened the nests to the ants more than violet glass, it would appear to do so less than red, green, or yellow.

I now made some experiments in order, if possible, to determine whether the reason why the ants avoided the violet glass was because they disliked the colour violet, or whether it was because the violet glass transmitted more of the ultra-violet rays.

For this purpose I placed a layer of the bisulphide of carbon over a piece of violet glass. By this arrangement I got the violet without the ultra-violet rays; and I then contrasted this combination with other coloured media.

First, I took a solution of bichromate of potash (bright orange), and placed it on a part of the nest side by side with the violet glass and bisulphide of carbon. I should add that the bichromate of potash also cuts off the ultra-violet rays. In all the following observations I changed the position after each observation.

At 1.30 P.M.	the ants	were	under the bichromate.
3	”	”	half under the bichromate and half under the violet glass and bisulphide.
8 A.M.	”	”	under the bichromate.
8.30	”	”	under the violet glass and bisulphide.
9	”	”	half under each.
9.30	”	”	some under each, but most under the violet glass and bisulphide.
9.45	”	”	half under each.
10	”	”	” ”

In this case, therefore, though without the layer of bisulphide the violet glass would always have been avoided, the result of

placing the bisulphide over the violet glass was that the ants did not care much whether they were under the violet glass or under the bichromate of potash.

I now took the same solution of carmine which I had already used.

10.	The ants were under the carmine.	
10.15	"	" "
10.30	"	most under the carmine, but some under the violet.
10.45	"	under the carmine.
11	"	most under the carmine, but some under the violet.

Here, then, again the bisulphide made a distinct difference, though not so much so as with the bichromate of potash.

I now took the solution of chlorate of copper already used.

1.	About half the ants were under each.		
1.30.	The greater number were under the violet glass and bisulphide.		
2.	ditto	ditto	ditto.
2.30.	ditto	ditto	ditto.
3.	Almost all were under the violet glass and bisulphide.		

Here, then, the addition of the bisulphide caused the violet glass to be distinctly preferred to the chlorate of copper.

I then took a solution of sulphate of nickel, almost exactly the same tint, or a shade paler than, the chlorate of copper.

At 3.45 the ants were under the violet glass and bisulphide.

4	ditto	ditto	ditto.
5	ditto	ditto	ditto.
Oct 18.			
7 A.M.	ditto	ditto	ditto.
8.	About half of the ants were under each.		

Here the same result was even more marked.

I then took some saffron 1 inch in thickness and of a deep-yellow colour.

12.45.	The ants were about half under each.		
1.	Most of the ants were under the violet glass and bisulphide.		
1.15.	ditto	ditto	ditto.
2.	Most of the ants were under the saffron.		

Here, again, we have the same result.

I then tried the different-coloured glasses, all of which, as I had

previously found, are unmistakably preferred to the violet. It remained to see what effect placing the bisulphide of carbon on the violet would have.

First, I placed side by side, as usual, a piece of green glass and the violet glass covered with bisulphide of carbon:—

1st exp. Half of the ants were under each.
2nd „ They were under the violet glass and bisulphide.
3rd „ „ „ „
4th „ Most of them „ „
5th „ „ „ „

Next, I tried pale-yellow glass.

1st obs. The ants were almost all under the violet glass and bisulphide.
2nd „ About three quarters were „ „
3rd „ They were all „ „
4th „ About half were under each.

I then took the dark-yellow glass.

1st obs. About half the ants were under the yellow glass and half under the violet glass and bisulphide.
2nd „ Most of them were under the violet glass and bisulphide.
3rd „ „ „ yellow glass.
4th „ „ „ violet glass and bisulphide.
5th „ About half under each.

I now took deep-red glass.

1st obs. The ants were under the red glass.
2nd „ Half of the ants were under each.
3rd „ Most of the ants were under violet glass and bisulphide.
4th „ Half were under each.

It seemed evident, therefore, that while if violet glass alone was placed side by side with red, yellow, or green, the ants greatly preferred any of the latter, on the other hand, if a layer of bisulphide of carbon, which to our eyes is perfectly transparent, was placed over the violet glass, they then went as readily, or even more readily, under it than under other colours.

In order to be sure that it was not the mere presence of a fluid, or the two layers of glass, to which this was due, I thought it would be well to try a similar series of experiments, using, however, a

layer of similar thickness (1 inch) of water coloured light blue by ammonio-sulphate of copper.

I therefore took again the piece of violet glass, over which I placed a flat-sided bottle, about 1 inch thick, containing a light-blue solution of ammonio-sulphate of copper; and, in contrast with it, I used the same coloured glasses as before.

First, I took the red glass.

Observation 1. Some of the ants were under each, but most under the red glass.
„ 2. All under the red glass.
„ 3. Almost all under the red.
„ 4. „ „
„ 5. „ „

I now took the green glass.

Observation 1. Almost all were under the green.
„ 2. All were under the green.
„ 3. Two thirds were under the green.
„ 4. All „ „
„ 5. „ „ „
„ 6. „ „ „

These experiments were made on a gloomy day; so I repeated them on a bright one, when the contrast was more marked.

Observation 7. All were under the green glass.
„ 8. „ „
„ 9. „ „ except two or three.
„ 10. „ „
„ 11. „ „
„ 12. „ „

I now took the dark-yellow glass.

Observation 1. All were under the yellow glass.
„ 2. „ „
„ 3. „ „
„ 4. „ „

I now took the light-yellow glass.

Observation 1. They were all under the light-yellow glass.
„ 2. „ „ „
„ 3. „ „ „
„ 4. „ „ „

These experiments seem to demonstrate that in the previous series the ants were really influenced by some property inherent in the bisulphide of carbon, and which affected their eyes, though it was insensible to ours.

I then thought it would be interesting to use, instead of the bisulphide, a solution of sulphate of quinine ($\frac{1}{2}$ dr. to 4 ounces), which differs from it in many points, but agrees in cutting off the ultra-violet rays. I used, as before, a layer about an inch thick, which I placed over violet glass, and then placed by its side the same coloured glasses as before.

First, I took the red glass.

Obs. 1. About half the ants were under each.
„ 2. Most of them were under the red glass.
„ 3. About half under each; rather more under the violet glass and sulphate of quinine than under the red glass.
„ 4. ditto ditto ditto.

I now took the dark-yellow glass instead of the red.

Obs. 1. Most of the ants were under the violet glass and sulphate of quinine.
„ 2. All „ „ „
„ 3. „ „ „ „
„ 4. „ „ „ yellow glass.
„ 5. „ „ „ „
„ 6. All of the ants were under the violet glass and sulphate of quinine.
„ 7. About half under each.
„ 8. Rather more under the violet glass and sulphate of quinine than under the yellow glass.

I then took the light-yellow glass instead of the dark.

Obs. 1. The ants were all under the violet glass and sulphate of quinine.
„ 2. Rather more than half under the yellow glass.
„ 3. Almost all under the violet glass and sulphate of quinine.
„ 4. All „ „ „

I then took the green glass instead of the yellow.

Obs. 1. They were under the violet glass and sulphate of quinine.
„ 2. „ „ „
„ 3. About half under each.
„ 4. About three quarters under the green glass.
„ 5. Almost all under the violet glass and sulphate of quinine.

I then tried similar experiments with a saturated solution of chrome alum and chromium chloride. These are dark greenish blue, very opaque to the visible light-rays, but transparent to the ultra-violet. I used a layer $\frac{1}{4}$ inch thick, which was still so dark that I could not see the ants through it; and for comparison, a solution 1 inch thick of bisulphide of carbon, moving them after each observation as before.

Exp. 1. The ants were under the bisulphide of carbon.
" 2. " " "
" 3. Most " " "
" 4. All but three " " "
" 5. All " " "

I now took chromium chloride instead of chrome alum.

Exp. 1. Most were under the bisulphide of carbon.
" 2. All " " "
" 3. Almost all " " "
" 4. About three fourths were under the chromium chloride.
" 5. All were under the chromium chloride.
" 6. About two thirds " "
" 7. About one half under each.
" 8. All under the bisulphide of carbon.
" 9. About three fourths under the bisulphide of carbon.
" 10. About half " " "
" 11. All under the chrome alum.
" 12. " bisulphide of carbon.

Thus, then, while if the ants have to choose between the violet and other coloured glasses, they will always prefer one of the latter, the effect of putting over the violet glass a layer either of sulphate of quinine or bisulphide of carbon, both of which are quite transparent, but both of which cut off the ultra-violet rays, is to make the violet glass seem to the ants as good a shelter as any of the other glasses. This seems to me strong evidence that the ultra-violet rays are visible to the ants.

Prof. Paul Bert has made ('Archiv de Physiol.' 1869, p. 547) some very interesting experiments on a small freshwater Crustacean belonging to the genus *Daphnia*, from which he concludes that they perceive all the colours known to us, being, however, specially sensitive to the yellow and green, and that their limits of vision are the same as ours.

Nay, he even goes further than this, and feels justified in con-

cluding from the experience of two widely divergent species—Man and *Daphnia*—that the limits of vision would be the same in all cases.

His words are :—

A. " Tous les animaux voient les rayons spectraux que nous voyons."

B. " Ils ne voient aucun de ceux que nous ne voyons pas."

C. " Dans l'étendue de la région visible, les différences entre les pouvoirs éclairants des différents rayons coloriés sont les mêmes pour eux et pour nous."

He adds, that " puisque les limites de visibilités semblent être les mêmes pour les animaux et pour nous, ne trouvons-nous pas là une raison de plus pour supposer que le rôle des milieux de l'œil est tout-à-fait secondaire, est que la visibilité tient à l'impressionnabilité de l'appareil nerveux lui-même ? "

Such a generalization would seem to rest on but a slight foundation ; and I may add that I have made some experiments myself on Daphnias which do not agree with those of M. Bert. I hope on some future occasion to have the honour of laying them before the Society.

At any rate, it seems to me that the preceding evidence strongly indicates that ants perceive the ultra-violet rays. Now, as every ray of homogeneous light which we can perceive at all appears to us as a distinct colour, it seems probable that these ultra-violet rays must make themselves apparent to the ants as a distinct and separate colour (of which we can form no idea), but as unlike the rest as red is from yellow, or green from violet. The question also arises whether white light to these insects would differ from our white light in containing this additional colour. At any rate, as few of the colours in nature are pure colours, but almost all arise from the combination of rays of different wave-lengths, and as in such cases the visible resultant would be composed not only of the rays which we see, but of these and the ultra-violet, it would appear that the colours of objects and the general aspect of nature must present to them a very different appearance from what it does to us.

Sense of Direction.

In continuation of the experiments recorded in my last paper (Linnean Journ. vol. xv. p. 177), I caused to be constructed a circular table 18 inches in diameter, the arrangement of which was kindly devised for me by Mr. Francis Galton. It consisted, as shown in figs. 1 and 2, of three concentric pieces—a central F G,

an intermediate DE, HI, and an outer piece BC, KL, each of these three pieces being capable of separate rotation.

Fig. 1.

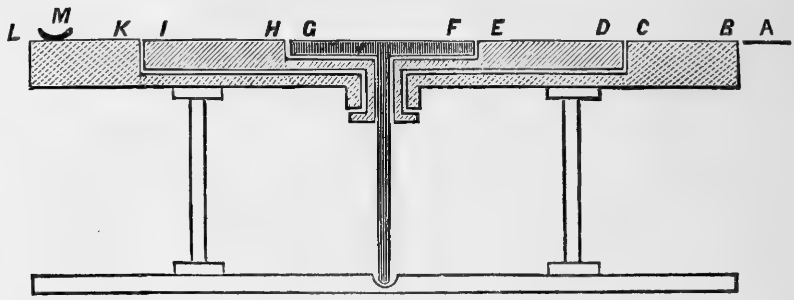
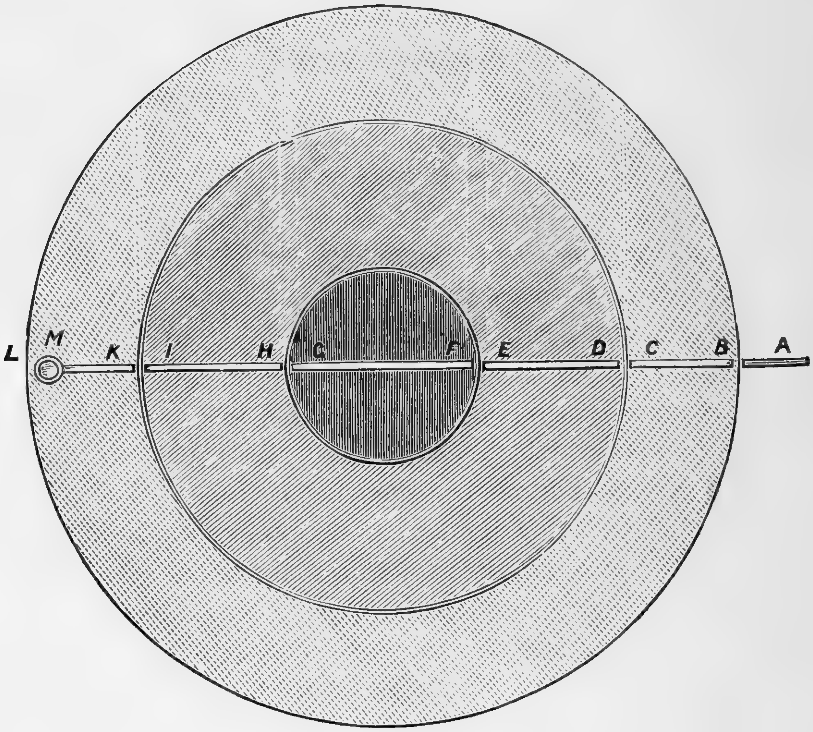


Fig. 2.



I then connected the table with a nest of *Lasius niger* by a paper bridge A, and also made a paper path across the table, as shown in fig. 2, divided into five pieces corresponding to the divisions of the table. This I did because I found that the ants wandered less if they were provided with a paper road than if they walked actually on the wood itself. I then placed a cup containing larvæ on the table at B, and put an ant on the larvæ. She at once picked one up, and, with some little guidance from

me, carried it off to the nest, returning at once for another, bringing some friends with her to help. When she knew her way, I gradually moved the cup across the table along the paper bridge to M. After a while the ants came to know the way quite well, and passed to and fro quite straight along the paper path from the nest to the larvæ at M. Having thus established a service of ants, I tried the following experiments:—

1. I removed the piece of paper G F. This disturbed them; but they very soon reestablished the chain.

2. I turned round the central piece of the table G F, so that the paper G F was reversed, G being where F had been, and *vice versâ.* This did not seem to disconcert the ants at all.

3. When the ants were between I and B, I rotated the outer circle of the table halfway round, which of course carried the cup containing the larvæ from L to B. The ants took no notice of this, but went straight to L.

4. When the ants were between I and B, I rotated the table several times, bringing it finally to the original position. This disturbed them a good deal; but eventually they all continued their course to L.

5. When the ants were between I and D, I half rotated the two centre parts of the table, the result of which, of course, was that the ant was moving away from, instead of towards, the nest. In every case the ants turned round too, so as duly to reach L. So also those which were on their way from the nest to the larvæ turned in the same manner.

6. When the ants were between I and D, I half rotated the whole table. Again the ants turned round too, though of course in this case, when they reached the place where L had been, the cup with the larvæ was behind them at B.

These two experiments, though quite in accordance with those previously made, puzzled me a good deal. Experiment 3, as well as those recorded in previous papers, seemed to show that ants were little guided in such cases by the position of surrounding objects. However, I was anxious to test this.

7. Accordingly I took a round box and placed it upside down on the table, having cut two niches, one at each side, where it lay on the paper path, so as to afford a passage for the ants, as in the experiments recorded in my previous paper; but on this occasion I left the lid on, cutting, however, a hole through which I could watch the result. In this case, therefore, the surrounding objects, *i. e.*

the walls of the box, turned round with the table. Then, as before, when the ants were between I and D, I turned the table half round. The results were as follow :—

	Ants which turned.	Ants which did not turn.
Exp. 1.	1	2
„ 2.	1	1
„ 3.	1	1
„ 4.	4	2
„ 5.	0	1
„ 6.	0	1
„ 7.	0	3
„ 8.	1	1
„ 9.	0	1
„ 10.	2	2
„ 11.	1	1
„ 12.	0	3
	11	19

In this case, then, only 11 ants turned; and as 4 of them were together, it is possible that 3 simply followed the first. Moreover, the ants which turned did so with much more hesitation and less immediately.

8. For comparison, I then again tried the same experiment, but without the box. The results were as follows :—

	Ants which turned.	Ants which did not turn.
Obs. 1.	3	0
„ 2.	3	0
„ 3.	3	1 ?
„ 4.	3	0
„ 5.	4	0
„ 6.	4	0
	20	1 ?

Under these circumstances, therefore, all the ants but one certainly turned, and her movements were undecided.

From these last two experiments it is obvious that the presence of the box greatly affected the result, and yet the previous results made it difficult to suppose that the ants noticed any objects so distant as the walls of the rooms, or even as I was myself. The

result surprised me considerably; but I think the explanation is given by the following experiments.

I again put some larvæ in a cup, which I placed in the centre of the table; and I let out an ant which I had imprisoned after the previous experiments, placing her in the cup; she carried off a larva to the nest and soon returned. When she was again in the cup, I rotated the table; when she came out she seemed a little surprised; but after walking once round the cup, started off along the paper bridge straight home. When she returned to the cup, I again half rotated the table. This time she went back quite straight. When she had come again, I once more half rotated the table; she returned quite straight. Again the same happened. A second ant then came: I half rotated the table as before. She went wrong for about an inch and a half, but then turned round and went straight home.

I was working by the light of two candles which were on the nest-side of the table. The next time the two ants came, I half rotated the table as before and moved the candles to the far side. This time the ants were deceived, and followed the paper bridge to the end of the table furthest from the nest. This I repeated a second time, with the same result. I then turned the table as before without altering the lights, and the ants (four of them) went back all right. I then again turned the table, altering the lights, and the ant went wrong.

I then altered the lights without rotating the table: the first ant went wrong; the second right; the third wrong; the fourth wrong; the fifth hesitated some seconds, and then went wrong; the sixth right; the seventh went all but to the edge the wrong way, but, after various wanderings, at last went right. When, therefore, the direction of the light was changed, but every thing else left as before, out of seven ants, five were deceived and went in the wrong direction.

After an interval of a week, on March 25, I arranged the nest and the rotating table as before, and let out three ants which I I had imprisoned on the 19th, and which knew their way. I put them on the larvæ at M as before. The paper pathway had been left untouched. The ants examined the larvæ and then went straight home along the paper path; but, to my surprise, only one of them carried off a larva. Nevertheless they had evidently taken the news to the nest; for the ants at once began coming to the cup in considerable numbers and carrying off the

larvæ. I do not altogether understand this proceeding, and unluckily had not marked the first three ants; so that I cannot tell whether they brought or sent their friends. It seems possible that they felt unequal to the exertion of carrying a burthen to the nest until they had had some food.

When the ants were fairly at work, I turned the table 90 degrees. In this case eight ants continued their march along the paper, while two turned back; but none left the paper, and went across the table straight for the larvæ.

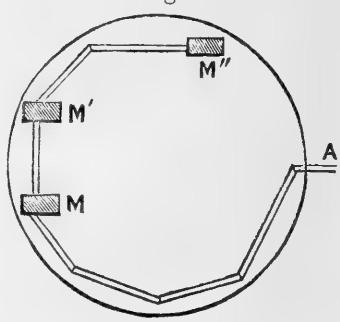
I then stopped the experiment for a while, so that the excitement might subside; as when the ants become too numerous it is not so easy to watch them.

When all was quiet, I put the cup with the larvæ on the middle of the table, and covered the greater part of the table with the box as before (p. 379). When the ants were leaving the cup on their way home, I then, as before, turned the table half round.

Under these circumstances, however, instead of turning as in the previous experiment, ten ants, one after another, continued their course, thus coming out of the box at the end furthest from the nest. When ten ants successively had, under these circumstances, gone wrong, I then, to make the experiment complete, tried it again, every thing being the same, except that there was no box. Under these circumstances five ants, one after the other, turned directly the table was rotated. It seems clear, therefore, that in determining their course the ants are greatly influenced by the direction of the light.

March 27. I let out two ants imprisoned on the 25th, and placed them on the larvæ, which I put on a column 7 inches high, covered with blue paper, and communicating with the nest by the paper path (A, fig. 3) arranged as usual, but supported on pins. At first I arranged it as shown below, placing the larvæ at M, so that the ants, on arriving at the larvæ, made nearly a semicircle round the edge of the table. I then gradually moved the larvæ to M′ and afterwards to M″. The ants, however, obviously knew that they were going unnecessarily round. They ran along the paper bridge in a very undecided manner, continually turning round and often coming down the pins; while in

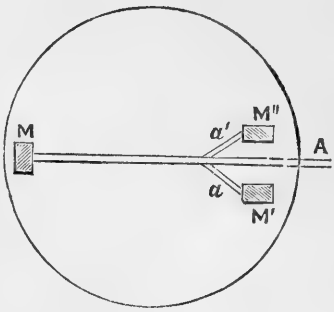
Fig. 3.



returning to the nest they persistently came down the side of the pillar nearest to the nest, though we repeatedly attempted to guide them the other way. Even when placed on the paper bridge between M and M′, they were very dissatisfied. In fact it was obvious that they knew they were being sent a long way round, and were attempting to make a shorter cut.

I then again placed the larvæ at M, and when the ants were once more going to and fro regularly along the paper path, I altered the position to M′, placing the edge of the pillar, which the ants had been accustomed to ascend, towards the paper bridge, connecting it with the original bridge by a side-bridge *a*, M being an inch from the original bridge. Under these circumstances three ants ran on to M; then two found their way over the bridge *a* to M′. Of the next ten ants, five went to M and five over *a* to M′. The next ten all went over the paper bridge *a* to M′.

Fig. 4.



I then put the pillar and the larvæ on the other side of the original paper path at M″ connected with the main path by a short bridge *a*′, and took for *a*′ a new piece of paper, so that scent would be no guide. I left the little bridge *a* in its place. The ants went as follows:—

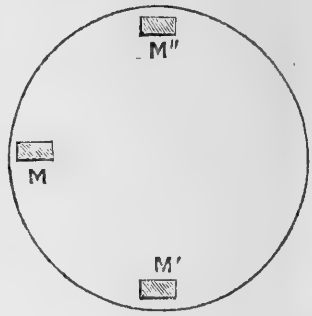
To M″.	M′.	M.
1	0	0
1	0	1
1	0	1
1	0	1
1	1	1
0	0	1
1	0	0
1	0	0
1	0	0
1	0	0
1	1	0
1	1	0
1	0	0
12	3	5

It seems clear, therefore, that though the ants did not trust so

much to their eyes as a man would have done under similar circumstances, yet that they were to some extent guided by sight.

I then removed all the paper pathways and put the pillar to M.

Fig. 5.



Of the two first ants which came to the table, the first found the pillar in 5 minutes, the second, after wandering about for a quarter of an hour, gave the search up in despair, and went home. I then moved the pillar to M′ and watched the next ant that came on to the table; she found it in a minute or two. I then moved it to M″. Two ants came together. One found the pillar in 7 minutes; the other took no less than 25. Obviously, therefore, though it seems clear that they are helped by sight, still these last observations support those previously recorded, and show that in finding their way they do not derive by any means so much assistance from their eyes as we should under corresponding circumstances.

Production of Queens.

I have mentioned in one of my previous papers that queens have never (so far, at least, as I had been able to observe) been produced in my nests. I was therefore much interested last year (1880) to find five queens developed in one of my nests of *Formica fusca*. The nest had been under observation since April 1879, and the eggs therefore must have been laid in captivity. The nest had been richly supplied with animal food, and this may possibly account for the fact.

It is known that bees, by difference of food &c., possess the power of obtaining at will from the same eggs either queens or ordinary workers. Mr. Dewitz *, however, is of opinion that among ants, on the contrary, the queens and workers are produced from different kinds of eggs. He remarks that it is very difficult to understand how the instinct, if it is to be called instinct, which would enable the working ants to make this difference can have arisen. This is no doubt true; but it seems to me quite as difficult to understand how the queens, which must have originally laid only queen eggs and male eggs, can have come to produce a third class. Moreover, however great the difficulty may be to

* Zeit. für wiss. Zool. 1878, p. 101.

understand how the ants can have learnt to produce queens and workers from one kind of egg, the same difficulty exists almost to the same extent in bees, which, as Mr. Dewitz admits, do possess the power. Moreover, it seems to me very unlikely that the result is produced in one way in the case of bees, and in another in that of ants. It is also a strong argument that in all my nests, though thousands of workers and males have been produced, I have never observed a queen to be so until this year. On the whole, then, though I differ from so excellent a naturalist with much hesitation, I cannot but think that ants, like bees, possess the power of developing a given egg into either a queen or a worker.

Affection and Kindness.

While I was watching one of my nests of *Formica fusca* on the 23rd of January last (1881), I perceived a poor ant lying on her back and quite unable to move. The legs were in cramped attitudes, and the two antennæ rolled up in spirals. She was, of course, altogether unable to feed herself. After this I kept my eye on her. Several times I tried uncovering the part of the nest where she was. The other ants soon carried her into the shaded part. On the 4th March the ants were all out of the nest, probably for fresh air, and had collected together in a corner of the box; they had not, however, forgotten her, but had carried her with them. I took off the glass lid of the box, and after a while they returned as usual to the nest, taking her in again. On the 5th March she was still alive; but on 15th, notwithstanding all their care, she was dead.

Longevity of Ants.

In my previous paper I have called attention to the considerable age attained by my ants; and I may perhaps be permitted to repeat here, *mutatis mutandis*, a paragraph from my last communication with reference to my most aged specimens, most of those mentioned last year being still alive. One of my nests of *Formica fusca* was brought from the woods in December 1874*. It then contained two queens, both of which are now still alive. I am disposed to think that some of the workers now in the nest were among those originally captured, the mortality after the first few weeks having been but small. This, of course, I cannot prove. The queens, however, are certainly seven, and probably eight,

* They are still alive and well, Sept. 25, 1881.

years old. In the following nests, viz. another nest of *Formica fusca*, which I brought in on the 6th June 1875, one of *Lasius niger* on the 25th July 1875 *, and of *Formica cinerea* on the 29th November 1875, there were no queens; and, as already mentioned, no workers have been produced. Those now living are therefore the original ones; and they must be between six and seven years old. I may add that in these nests there have been for the last year very few deaths †.

In conclusion, I may place on record a new species of mite which I have found in nests of *Lasius flavus*, and of which Mr. Michael has been good enough to draw up the following description.

UROPODA FORMICARIÆ, sp. nov.

This species, although it falls strictly within the genus *Uropoda*, and not within Kramer's genus *Trachynotus* as defined by that writer, still in most respects, except the very distinctions upon which the genus is founded, resembles *Trachynotus pyriformis* (Kramer) more closely than it does any other recorded species. It is, however, decidedly different; and is characterized by the squareness of its abdomen, the thickness and roughness of its chitinous dermal skeleton, and *especially* by the powerful chitinous rdiges or wing-like expansions on the lateral surface between the second and third pair of legs.

Length, ♂ and ♀, about ·95 millim.
Breadth „ „ ·55 „

The abdomen is almost square, but somewhat longer than broad, and slightly narrowed at its junction with the cephalothorax, from which it is not plainly distinguished. The extreme edge is a strong chitinous ridge bordered with a thick fringe of short, stout, curved hairs, as in *T. pyriformis*. The dorsal surface of the cephalothorax is also narrowed towards the front, and has a curved anterior margin bent down so as to protect the mouth, as in that species; it bears a few of the same kind of hairs as the abdomen, and has a chitinous thickening at each side. The abdomen rises almost perpendicularly from the marginal ridge. There is a central depression occupying the posterior half, or rather more than half of the abdomen; and at the bottom of this depression are transverse ridges, the hinder ones nearly straight, and the anterior ones bent

* The last of these died on June 15, 1881.

† These ants died off somewhat rapidly, the last on July 23, 1881.

in the middle, the central point being forward; at the sides of, but not in, this depression, are two chitinous blocks which seem to form a starting-point for the ridges. Anterior to this depression the central portion of the creature, *i. e.* its longitudinal dorsal axis, is higher in level than in parts nearer the margin, and forms an irregular triangle of rough chitine. A broad chitinous plate or ridge projects on each side above the second leg, and between that and the third, evidently for their protection; it is probably flexible at the will of the creature, as in the genus *Oribates*.

The sternal surface has strongly marked depressions for the reception of the legs. The coxæ of the first pair of legs are largely developed, flattened, almost touch in the median line, and nearly conceal the mouth, as in the typical *Uropodas*. The genital opening of the male is rather large, round, and placed centrally between the coxæ of the second pair of legs. The female appears only to be distinguished from the male by being more strongly chitinized, and by the conspicuous valval plate which occupies the whole space between the coxæ of the second and third pairs of legs and extends beyond both.

The nymph is less square in the abdomen than the adult, and the border of hairs is absent; the margin is somewhat undulated, the concave undulations being so placed as to give free action to the legs when raised; the central depression of the abdomen is far less marked than in the adult; a slight ridge runs all round the dorsal surface a little within the margin; four ridges, two anterior and two posterior, run from the circumscribing ridge to a raised ellipse in the centre; there are not any plates for the protection of the legs, and the coxæ of the first pair are not flattened as in the adult.

This mite lives in the nests of *Formica flava*.

Mollusca of H.M.S. 'Challenger' Expedition.—Part VIII.

By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S., &c.

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[Read March 3, 1881.]

Fam. Pleurotomidæ, *J. Gwyn Jeffreys.*

Pleurotoma, *Lam.*

1. *Pleurotoma* (*Surcula*) *staminea*, n. sp.
2. *P.* (*S.*) *trilix*, n. sp.
3. *P.* (*S.*) *lepta*, n. sp.
4. *P.* (*S.*) *rotundata*, n. sp.
5. *P.* (*S.*) *goniodes*, n. sp.
6. *P.* (*S.*) *plebeia*, n. sp.
7. *P.* (*S.*) *syngenes*, n. sp.
8. *P.* (*S.*) *hemimeres*, n. sp.
9. *P.* (*S.*) *anteridion*, n. sp.
10. *Pleurotoma* (*Surcula*) *rhysa*, n. sp.
11. *P.* (*S.*) *bolbodes*, n. sp.
12. *P.* (*S.*) *ischna*, n. sp.
13. *P.* (*Genota*) *didyma*, n. sp.
14. *P.* (*G.*) *engonia*, n. sp.
15. *P.* (*G.*) *atractoïdes*, n. sp.
16. *P.* (*Drillia*) *pyrrha*, n. sp.
17. *P.* (*D.*) *paupera*, n. sp.

1. Pleurotoma (Surcula) staminea, n. sp.

St. 146. Dec. 29, 1873. Lat. 46° 46′ S., long. 45° 31′ E. Marion Island, Prince Edward Island. 1375 fathoms. *Globigerina*-ooze. Bottom temperature 35°·6.

St. 149 J. Jan. 29, 1874. Lat. 46° 43′ S., long. 69° 15′ E. W. Christmas Harbour, Kerguelen. 105 fms. Mud.

Shell.—High, narrow, biconically fusiform, scalar, carinated, with spiral threads, thin, white. *Sculpture.* Longitudinals—the shell is scored with coarse irregular sinuous lines of growth; but there is no trace of any other longitudinal markings. Spirals—above the middle of each whorl is a strong carination only slightly projecting, but marked by the angulation of the whorl and by the prominence of the thread on its crest. On the body-whorl there is a tendency to a second carination, which runs into the mouth just below the junction of the outer lip, and is thus concealed on all the earlier whorls (it is evident that this inferior angulation is a feature which varies much in different individuals). Besides these, the whole surface is covered with irregular and unequal threads; these are feeblest on the sloping shoulder below the suture: close below the upper keel and on the snout and its conical base they are fine; about 4 above and 2 below the lower keel are the strongest, but they all tend to subdivide themselves; and the whole shell is scored by irregular and somewhat broken microscopic lines. *Colour* translucent white under a thin, pale,

greyish-yellow *epidermis*, which adheres closely, but is apt to rub through. *Spire* is high, narrow, conical, and slopingly scalar in consequence of the drooping shoulder between the suture and the keel. *Apex* is more or less eroded in all the four specimens: it consists of not more than $1\frac{1}{4}$ embryonic whorls, which are globose, smooth, and with the point a little obliquely pressed down. *Whorls* $8\frac{1}{2}$, rather short except the last, of regular increase, angulated above the middle; the shoulder between the suture and the keel is straight-lined. From the keel the whorls are slightly contracted to the inferior suture, and the profile-line here is scarcely convex. The last whorl is feebly tumid below the keel, and is drawn out from a produced conical base into a long, narrow, cylindrical, very slightly upturned snout, which projects on the right side of the base. *Suture* a fine, sharp, slightly irregular line, well defined by the contraction of the whorl above and the straight line of the shoulder on the whorl below. *Mouth* club-shaped, being oval above, and prolonged below into a long, but not very narrow, canal, which is a little sinuous, and widens towards its end in consequence of the oblique cutting-away of the pillar-lip. *Outer lip*, which is thin, sharp, and patulous, leaves the body at a right angle and advances quite straight to the keel, above which lies the deep, thin-lipped, U-shaped sinus, whose lower margin runs parallel to, but a little above, the carinal thread; from the keel the lip-edge advances with a long, free, forward curve and a sinuous double sweep, first convex and then concave, to the point of the snout, where the edge is prominent, rounded, and patulous. *Inner lip* almost hyaline, being cut into the substance of the body-whorl, but not extending beyond the mouth-edge; it is slightly concave above, straight in the middle, and very early and obliquely cut away in front, from which point, for the sixth of an inch, it advances to the extreme point of the shell as a delicate, thin, sharp lamina bordering the canal. The operculum seems to have been broken, probably in the attempt to extract it; but it is obviously small, thin, and pale yellow. H. 1·6. B. 0·51. Penult. whorl, height 0·24. Mouth, total height 0·83, breadth 0·28.

The animal of this species is preserved in one specimen, that from St. 146; it is deeply retracted, and is of a pale buff colour.

The name I have selected is descriptive of the sculpture of the shell.

2. Pleurotoma (Surcula) trilix, n. sp.

St. 150. Feb. 2, 1874. Lat. 52° 4′ S., long. 71° 22′ E. Between Kerguelen and Heard Island. 150 fms. Rock. Bottom temperature 35°·2.

Shell.—High, very narrow, biconically fusiform, subscalar, bicarinated, strong, white. *Sculpture.* Longitudinals—there are very many unequal, strong, harsh, flexuous lines of growth, of which one every here and there is stronger than the rest. Spirals—there are two keels, of which the upper and stronger lies a little above the middle of the whorls, is sharply pinched out, but has a rounded edge; there is a drooping, but straight-lined shoulder above, and the whorl is somewhat contracted below it, so that it has considerable prominence; the lower keel is a rounded, rather prominent thread, which is the more conspicuous from the contraction of the whorl below it into the suture; between these two keels, more or less in the middle, lies a thread, which is more marked than any of the others which, coarse, unequal, and interrupted, closely cover the whole surface; of these two or three in the line of the sinus on the shoulder, between the upper keel and the suture, are somewhat stronger, more regular, and swoln than the rest; while just below this point, where the lines marking the lower edge of the sinus run, the surface is almost free of spiral threads. *Colour* porcellanous white. *Epidermis* extremely thin, smooth, pale yellowish. *Spire* high, narrow, subscalar. *Apex* consists of $1\frac{1}{4}$ embryonic whorls, globose, smooth, and somewhat obliquely pressed down on one side at the extreme point. *Whorls* $7\frac{1}{2}$, narrow, angulated, with a straight drooping shoulder below the suture, slightly concave between the keels, contracted into the lower suture; the base is conical, and projects on the right side into a long, narrow, and very slightly twisted snout. *Suture* a fine, sharp, deeply impressed line. *Mouth* club-shaped, being oval above, with a sharpish angulation at the upper point, and being prolonged into a long, rather narrow, but slightly widening canal, which is open in consequence of the oblique cutting away of the pillar-lip. *Outer lip*, which is thin, sharp, and patulous, with a slight contraction on the edge of the canal, leaves the body nearly at a right angle, and advances with a very slight convexity to the keel, above which lies the deep, thin-lipped, U-shaped sinus, whose lower margin lies parallel to, but a little above, the conical thread; from the keel the lip has an edge which on the front is first convex and then very

slightly receding, while on the side it is first convex and then concave to the point of the snout, where its course is very straight. *Inner lip* a thin porcellanous glaze, spreads a little on the body, from which the spirals are slightly cut away; the lip is a little concave above, then straight, and is early and obliquely cut away on the front of the pillar, where it is slightly prominent, and finally it runs out to the point of the snout as a thin edge bordering the canal. H. 1·47. B. 0·48. Penultimate whorl, height 0·24. Mouth, total height 0·8, breadth 0·26.

This species extremely resembles *P. staminea*; nor should I be at all surprised if, on a fuller series of specimens being obtained, the two species should be ultimately united; but the four specimens of the former and the three of the present species obtained by the 'Challenger' are constant to one another and easily distinguishable. Besides distinctions which stand out in the description, the form in *P. trilix* is slimmer, as if the whorls were more closely twisted; the snout is longer, finer, a little twisted, and is striated to the point; the shell is stronger, the pillar-edge of the front canal where obliquely cut off is a little more contracted; the suture is much more deeply impressed, the apex is a very little larger, and very slightly more pressed down on one side. The sculpture, too, is crisper, sharper, and smaller in the spirals, so as to produce a markedly different texture. In *P. staminea*, where an inferior keel faintly appears, it lies much lower than in *P. trilix*, in which it lies markedly above the suture.

3. Pleurotoma (Surcula) lepta, n. sp.

St. 157. March 3, 1874. Lat. 55° 55′ S., long. 108° 35′ E. Southern Ocean, S.E. of Australia. 1950 fms. Diatom-ooze. Bottom temperature 32°·1.

Shell.—High, fusiform, rather tumid, conical, with a produced base and a very long fragile snout, thin, white, with very little sculpture. *Sculpture.* Longitudinals—the whole surface is closely scored with fine striæ in the lines of growth; of these, at irregular intervals of about $\frac{1}{100}$ inch apart or rather more, one rises into greater strength and prominence as a rounded thread; these are stronger and more regular on the earlier whorls than on the last. Spirals—two thirds down the whorls is a blunt angulation bearing 4 or 5 fine, close-set, rounded threads; on the last whorl the angulation is obsolete, but its place is defined by the group of close-set threads; on the rounded shoulder above these are microscopic striæ and very indefinite rounded threads; below the angula-

tion are 5 or 6 pretty prominent, unequal, narrow, remote, rounded threads; the one which comes out from the suture at the upper angle of the mouth, and which defines the base, is somewhat stronger than those above it, and this one is succeeded on the base by a series of others, similar, but more remote, with occasionally a finer one between; on the base they become feebler, less regular, and, on the whole, more remote; the surface of the shell between these is faintly scored microscopically. *Colour* porcellanous white and semitransparent, from the thinness of the shell. *Epidermis* an excessively thin, pale-yellow, smooth membrane, which is very easily rubbed off. *Spire* high and conical, and yet almost globose from the rapid increase of the rounded whorls; its profile-lines are much interrupted by the sutural contractions. *Apex* consists of $1\frac{1}{2}$ embryonic whorls, and is small, rounded, mamillary, prominent, but a little flattened down on one side. *Whorls* 6, of very rapid increase, the last particularly so; they are very tumid and well rounded, with only a slight angulation, above which is a long convex shoulder, while below it the whorl contracts very slightly; the last is very large, being not only tumid, but having an elongated base which, though considerably hollowed out on the left side, is very little narrowed on the right, and is produced into a long, conical, largish snout, which projects almost entirely on the right side of the axis. *Suture* rather broad and deeply sunken, and almost a little canaliculated. *Mouth* long, large, club-shaped, being oval and bluntly pointed above, and having a long, rather narrow, and open canal below. *Outer lip* very sharp and thin, a little contracted except along the canal, where it is slightly patulous; the curve of the lip, which is very steep above, passes over, by a slightly flattened arch and a concave curve below, to a straight line along the canal; its edge, on leaving the body, retreats rather rapidly to the left, forming the deep semicircular sinus which occupies the whole shoulder from the suture to the angulation; the lower edge of the sinus is very low-shouldered, but advances very prominently below, and retreats no more till it reaches the extreme point of the shell. *Inner lip* is hollowed rather broadly out of the shell-wall, the edge of which rises sharply, but very thinly, outside; it spreads across the whole of the rather short and early truncated pillar, which has a long, oblique, rounded, and slightly twisted edge, and which above joins the body with a very slightly concave curve. *Operculum* pale yellow, thin, oval,

broadly rounded in front where the nucleus lies, pointed behind, rather finely roundedly striate in the loop-lines of growth, which are crowded, not on the pillar-edge, but on that lying toward the outer lip of the shell. The body of the animal is a pale-buff colour, but cannot be extracted without sacrificing the shell. H. 1·6. B. 0·65. Penultimate whorl, height 0·27. Mouth, height 0·1, breadth 0·43.

This singularly beautiful species has some resemblance to *P. clara*, v. Mart. (*nec* Reeve), from Patagonia, 60 fms., and is, like that and those previously described here, eminently characteristic of frigid waters. It wants the carination of that species, has a longer and more inflated body-whorl, with a smaller and shorter apex, a more contracted suture, and stronger spiral threads.

4. Pleurotoma (Surcula) rotundata, n. sp.

St. 246. July 2, 1875. Lat. 36° 10′ N., long. 178° E. Mid Pacific, E. of Japan. 2050 fms. Grey ooze. Bottom temperature 35°·1.

Shell.—High, narrow, fusiform, conical, with rounded whorls and a shallow suture, below which the inferior whorl swells out tumidly; the last whorl is short and rounded, with a constricted conical base and a long narrow snout. *Sculpture.* Longitudinals—there are strongish, close-set, rounded, hair-like lines of growth, specially strong below the suture. Spirals—over the whole surface are strong, but unequal, rather distant, sharpish threads; those in the sutural area are, with two or three exceptions, weaker than those elsewhere; about three at the periphery are somewhat prominent. *Colour* porcelain-white under a thin yellow epidermis. *Suture* fine, superficial, but well defined. *Mouth* is club-shaped, being oval, with a long narrow canal below and a blunt angulation above. *Outer lip* very evenly curved, but a little more steeply above than below; it is drawn out into a long straight line along the side of the canal; the edge-line, on leaving the body, retreats very straight toward the left to the rather remote, wide, and openly rounded, but very deep sinus, between which and the body-whorl lies an acute triangular shelf, while below is the very high shouldered and prominent lip. *Inner lip* is exceptionally narrow, but strong and marginated; it is very little concave at the junction of the body and the pillar, which is long, narrow, and is cut off at the point with a long, little oblique, sharp, and scarcely twisted edge. H. (?) 1·65. B. 0·6. Penultimate whorl, height 0·22. Mouth, height 0·9, breadth 0·3.

This is a species of interest, both from its habitat and from the simplicity of its rounded whorls and of its sculpture. It exists unfortunately in the form of a mere fragment. It is a good deal like *P. planetica*, Edw., from the Eocene Bracklesham beds (see Eocene Moll., Palæont. Soc. p. 212, pl. xxvi. fig. 3), but has not the flatly constricted band below the suture, which in that species throws the whorls out in a high rounded shoulder. In *P. rostrata*, Edw. (*l. c.* p. 218, pl. xxvi. fig. 8), though with less of a shoulder, there is a broader constricted belt, and there are traces of longitudinal ribs.

5. Pleurotoma (Surcula) goniodes, n. sp. (γωνιώδης, angular.)

St. 320. Feb. 14, 1876. Lat. 37° 17′ S., long. 53° 52′ W. S.E. of La Plata. 600 fms. Hard ground. Bottom temperature 37°·2.

Shell.—High, narrow, biconical, subscalar, with a long, unconstricted base and a subequal-sided snout, angulated with an expressed keel, and with regular fine spiral threads all over. *Sculpture.* Longitudinals—there are only fine, regular, close, hair-like lines of growth. Spirals—in the middle of each whorl is a strong angulation formed by the straight drooping line of the shoulder and the straight contracting line down to the inferior suture; the angulation is pinched out into a sharp round-edged keel; there are fine sharpish threads on the whole surface pretty equally distributed and of equal strength; of these there are on the penultimate whorl below the keel about 6; they are parted by flat broadish intervals, strongly scored with the lines of growth. *Colour* white under a yellow epidermis. *Spire* high, narrow, conical, with profile-lines interrupted by the straight-lined contraction of the shell between the keels of the successive whorls. *Apex* (eroded) small and rounded. *Whorls* 6–7; their profile consists of two straight lines meeting in the keel which bisects the whorls; above is a slowly sloping shoulder, and below a gradual contraction to the suture; the last whorl is scarcely convex on the conical base, which contracts with great regularity to the long, nearly equal-sided snout. *Suture* fine, linear, but well defined. *Mouth* club-shaped, being rhomboidal above, with a long narrow canal below. *Outer lip* high-arched and then straight along the canal; its edge retreats at once to the left, and forms a remote, deep, rounded sinus in the shoulder above the keel; below this

it sweeps out into a high and prominent shoulder. *Inner lip* little concave at the junction of the body and pillar, which is straight above, but towards the point is obliquely cut off with a long, narrow, twisted edge, and bends a good deal to the left. H. 0·9. B. 0·38. Penultimate whorl, height 0·16. Mouth, height 0·51, breadth 0·22.

This is a stumpier form than *P. leucotropis*, Ad. & Rve., with a more conical and less constricted base, and shorter and more bent snout. From *P. oxytropis*, while differing, of course, still more markedly in most of these points, it differs yet more in sculpture. Though a much smaller and narrower form and with a more conical and less tumid base, it is in a general way very like *P. circinata*, Dall; but that is destitute of the spiral sculpture on the shoulder, which seems also to be the case with *P. Kennicottii*, Dall, a smaller form than *P. circinata*, and which is also distinguished by a double keel on the last whorl.

6. Pleurotoma (Surcula) plebeia, n. sp.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—High, narrow, fusiform, subscalar, angulated and tubercled on the angle, strong, rough, yellowish white. *Sculpture.* Longitudinals—the upper whorls are nearly bisected by a bluntish angulation, which is made more marked by about 20 small, oblique, longitudinally elongated knobs, of which scarcely a trace appears below or above the keel; they become fewer up the spire and die out on the last whorl; there are very many, rough, very unequal, curved lines of growth. The whole surface is covered by coarse, unequal, and very irregular threads, varying in their direction, and interrupted by the longitudinal lines of growth; these threads are most equal in the infrasutural tract, where the line of the old sinus-markings lies; below the keel they occur alternatingly as stronger and finer; on the base and snout they are coarse, but almost disappear on the point; they and the suture are exceptionally independent of one another. *Colour* yellowish porcellanous white. *Spire* high, narrow, conical, and slopingly subscalar. *Apex* broken. *Whorls* probably 9–10, rather narrow, somewhat hollowed on the shoulder below the suture; below the keel their profile-line is straight, but contracted to the suture below. The base (whose upper limit is defined by a very slight angulation) is conical, drawn out pretty much in

the axial line into a long, narrowish, cylindrical, strong, and slightly reverted snout. *Suture* a rather minute, sharp, somewhat irregular line, which does not at all follow the spiral markings, but crosses these up and down in an unusally irregular manner; it is well defined by the concave hollow formed by the contraction of the whorls above and below it. *Mouth* club-shaped, being somewhat angularly ovate above (with a sharpish point at the top and an angulation at the keel), and prolonged below into the somewhat oblique open canal, which is kept open by the oblique cutting away of the pillar. *Outer lip* sharp, but strong; it leaves the body at an acute angle and retreats towards the left to form the sinus, which is open and near, but not immediately at the body: from the sinus the lip-edge advances with a strong forward convexity to the point of the canal; laterally it is also rather convex, but is contracted into the snout, along the edge of which it is pretty straight with a somewhat oblique direction towards the left, and here it is patulous. *Inner lip* porcellanous, smooth, narrow, cut off, and slightly twisted in front, and running out at the point to a sharp edge along the canal, the point of which is then rounded and patulous. H. 1·5. B. 0·5. Penultimate whorl, height 0·23. Mouth, total length 0·7, breadth 0·23.

In this species the generic sinus lies high and is open, which reduces to rather small dimensions the little testaceous shelf which forms its upper edge and separates it from the body-whorl; but the sinus does not, as in *Defrancia,* lie quite at the upper angle of the mouth. The shell has some resemblance to *P. nodifera,* Lam., from China and the Philippines; but in that species the body-whorl is much more tumid, the canal is much longer and is more bent to the left, the apex is more uninterruptedly conical, the suture is deeper, the spiral threads are not so universal and are in their course regular. In texture this species is very much like *P. nivalis,* Lovén.

7. PLEUROTOMA (SURCULA) SYNGENES, n. sp. (*συγγενής,* allied.)

St. 23. March 15, 1873. Lat. 18° 24′ N., long. 63° 28′ W. Sombrero Island, off St. Thomas, Dan. W. Indies. 450 fms. *Globigerina*-ooze.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 20″ W. Culebra Island, off St. Thomas, Dan. W. Indies. 390 fms. Coral-mud.

Shell.—Long, narrow, biconically fusiform, sharply carinated and tubercled on the keel, polished, thin, white. *Sculpture.* Longitudinals—there are very many, fine, close-set, slightly raised flexuous lines of growth. Spirals—there is a sharp keel which lies about $\frac{2}{3}$ down the whorls; it is very prominent from the concavity of the whorl above and below; the sharpness of this keel is due not so much to its crest, which is rounded, but to its being beset by prominent round, conical, pointed tubercles, of which there are about 15 on the penultimate whorl; on the upper whorls these are fewer, but they begin at once on the first whorl below the embryonic shell; on the last whorl they disappear entirely toward the mouth. Besides the carina, there are many delicate lines; three or four of these, very fine, smooth, and flat, come in below the suture; at about $\frac{1}{50}$ inch below the suture is a fine, sharp, engraved line; about 6 more of these, but less strong, come in above the keel. Below the keel the sculpture is somewhat similar, but less distinct and less regular. On the snout the interstices rise into rounded, slightly roughened threads, which on the extreme point become feebler. *Colour* ivory-white. *Spire* high, narrow, conical, but with the profile-lines broken by the deep concave curves at the sutures. *Apex,* the $2\frac{1}{2}$ embryonic whorls are small, cylindrical, and bluntly rounded at the top, which is slightly pressed down on one side. *Whorls* $11\frac{1}{2}$, strongly angulated, with a concave curve between the keels; they are rather narrow and of very slow increase: the last one is a little tumid, with a very regular convex curve, which contracts evenly to a long, projecting, narrow, cylindrical snout, lying very nearly in the axis of the shell. *Suture* a very faint, delicate, and regular line, well defined by the concavity of the whorl both above and below it. *Mouth* club-shaped, but long and narrow, sharply pointed above, and very much twisted in consequence of the great depth and width of the sinus. *Outer lip,* originating markedly below the keel it leaves the body at a very acute angle; its edge, which is sharp throughout, retreats at once, forming a very narrow and short ledge between the body-whorl and the sinus, which is rounded and open, and whose depth is due entirely to the great forward sweep of the lip below, where it projects like the pinion of a wing and is slightly patulous; it curves in laterally to the origin of the canal, and then advances very straight and scarcely patulous to the rounded point of the shell. *Inner lip* is slightly cut out of the substance of the shell, is very

narrow and very straight, the cutting away of the point of the pillar being very gradual and very slightly oblique. H. 1·13. B. 0·33. Penultimate whorl, height 0·12. Mouth, total height 0·58, breadth 0·16.

The tubercled angulation of this species recalls faintly a similar feature in *P. nivalis*, Lov., Norway and Britain, and *P. plebeia*, W. It is slightly like *P. unifasciata*, Sow., from W. Columbia, but is much longer in the canal. It is very near to *P. dimidiata*, Broc. (a Sub-Apennine Miocene species), of which there are specimens (perhaps the *P. Powerii*, Calcara, which Libassi holds to be a variety of *P. dimidiata*) as slim as the 'Challenger' species; but in Brocchi's species the keel is sharper and persists to the mouth-edge; on the same length of shell it has two whorls less; from the suture, which is not in the least impressed, the whorl, before expanding to the carina, descends in a cylindrical or even slightly contracting form; the surface is a little roughened with slightly raised threads; the lines of growth run from the suture forward at first toward the right, not, as in the 'Challenger' species, at once to the left into the sinus; and the embryonic whorls are more rounded, with a deeper suture and half a whorl fewer. It extremely resembles *P. undata*, Lam., an Eocene fossil from Grignon; but has the spire more attenuated, the suture rather deeper, while the tubercles on the keel do not, as there, become longitudinal ribs, and the snout is much longer.

8. Pleurotoma (Surcula) hemimeres, n. sp. (ἡμιμερὴς, halved.)

St. 120. September 9, 1873. Lat. 8° 37′ S., long. 34° 28′ W. Pernambuco. 675 fms. Mud.

Shell.—High, conical, with a small round-tipped conical apex; ribless, but with a keel beset with longish narrow tubercles. *Sculpture.* Longitudinals—there are only fine hair-like lines of growth. Spirals—about $\frac{2}{3}$ down each whorl is a very sharp and prominent angulation, and the keel thus formed is beset by numerous small, sharpish, narrow and elongated tubercles, which fail to become ribs; of these tubercles there are about 12 on the earlier whorls, and they become more numerous on the succeeding whorls. Below this keel there is a straight-lined contraction; above it there is a long, slightly concave shoulder, with a delicate row of small tubercles at the top close to the suture. Both rows of tubercles, but especially the upper, are very sharp and distinct on

the earlier whorls, but lose individuality further down the spire. From the keel downwards the whorls are scored with flat rounded threads. *Colour* pale buff, deepening somewhat up the spire, glossy. *Spire* high, conical, the profile-lines only slightly interrupted by the prominence of the tubercled keel. *Apex*: the two embryonic whorls are smooth, small, conical, with a small rounded tip slightly flattened down on one side. *Whorls* 9 (remaining), short, of very regular increase, slightly concave in the shoulder, sharply angulated at the keel, and contracted into the suture below. The whole base and pillar have been broken away. *Suture* rather oblique, defined by the slight contraction of the superior and inferior whorls. *Mouth* is broken, but the sinus is broad, rounded, and deep, in consequence of the long forward sweep of the pinion-like edge of the outer lip.

This species exists only in one fragment; but its beauty and its strongly marked features make it worth notice. It extraordinarily resembles *P. dimidiata*, Brocchi, but is a broader shell, with a coarser stumpier apex of fewer embryonic whorls, has no spirals above the keel, while those below are finer; the suture is much less sunken between the keels, and there is a substantial coronet of tubercles. *Pleurotoma Powerii*, Calcara (a specimen of which I owe to the kindness of the Abbé Brugnone), has the upper part of the whorls above the keel free of spirals, and the apex is more like that of *P. hemimeres*, but in form it is still slimmer than *P. dimidiata*, and its sculpture otherwise is even less like.

9. Pleurotoma (Surcula) anteridion, n. sp.

St. 142. December 18, 1873. Lat. 34° 4′ S., long. 18° 37′ E. Off the Cape of Good Hope. 150 fms. Sand. Bottom temperature 47°.

Shell.—High, narrow, biconically fusiform, subscalar, with angularly convex and longitudinally-ribbed whorls, thin, tawny. *Sculpture.* Longitudinals—a little way below the suture is an angulation where narrow, raised, oblique ribs begin; these slope from left to right; they extend to the suture, but not to the base, where they die out more gradually than they arose; they are parted by rounded hollows, which are wider than the ribs. There are about nineteen of these ribs and hollows on the last whorl, but fewer on each preceding one; besides these, there are very many fine hair-like flexuous lines of growth. Spirals—the shoulder below the suture (the sinus-area) has a few faint

regular scratch-like lines; on the ribbed area these are stronger. On the base the interstices become somewhat narrower and more convex, till on the snout they rise into strongish threads, which at the very point again become weaker. *Colour* a light tawny, paler on the snout, and white on the pillar. *Spire* high, conical, and slopingly subscalar. *Apex* broken. *Whorls* probably 10, rather short, with a straight somewhat drooping shoulder, convex, and appearing contracted below in consequence of the dying out of the longitudinal ribs as they approach the suture. The conical base contracts rather rapidly, and is prolonged into the straight, very slightly reverted, direct, narrow, cylindrical snout. *Suture* a fine, regular, squarely impressed line, whose course diverges a good deal from that of the spirals of sculpture. *Mouth* club-shaped, being roundly oval and not angulated above, and with a long, narrow, slightly twisted canal below. *Outer lip* sharp and thin, with a very regular curve from the suture to the base of the snout, along the edge of which it runs sharp and straight to the open, rounded, and thin point; when it leaves the body, it retires at once to the left, forming a deep, rounded, open sinus; from this point its edge sweeps out in a full convex curve, retreating slightly at the base of the snout, and then advancing straight to the point. *Inner lip* porcellanous, longitudinally marked, narrow, straight, cut away obliquely to a long fine point; and then continued along the canal in a thin sharp edge, which toward the point is slightly cut off backwards. H. 0·9. B. 0·32. Penultimate whorl, height 0·13. Mouth, total height 0·45, breadth 0·19.

The narrow sharpish ribs of this species are suggestive of small buttresses, from which feature the name is taken. The specimen is slightly chipped, and is, I think, not quite full-grown. It a little resembles the young of *P. tenuis*, Reeve, from China; but the longitudinal ribs are not nodulous. In form it slightly recalls *P. undatiruga*, Bivona, but in texture and all details is utterly different.

10. Pleurotoma (Surcula) rhysa, n. sp.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Pernambuco. 350 fms. Mud.

Shell.—High, narrow, conical, with a small apex, a contracted, conical base, and a longish narrow snout; carinated, ribbed, with spiral threads, pale buff. *Sculpture.* The whole surface is frosted

over with microscopic tubercles. Longitudinals—there are on the last whorl 16, narrow, raised, sinistrally convex, and rather oblique ribs; originating at the angle of the whorls, where they are a little tuberculated and swollen, they are parted by furrows of about the same breadth as themselves; they die out across the base, and do not appear on the snout. There are about 13 on the penultimate whorl, and they diminish rapidly up the spire; the lines of growth are exceedingly faint and few, but sharp; they are most visible in the sinus-area and on the snout. Spirals—the suture is marginated above by a minute thread, which lies at the bottom of the superior whorl, and below by a somewhat stronger thread, which lies at the top of the inferior whorl. The sinus-area is bare. Slightly above the middle of the whorls is the strong angulation, to which the prominence of the ribs originating at this point gives great additional sharpness and distinctness. From this to the point of the shell the surface is scored by rounded and prominent threads; of these there are three, pretty equal, on the earlier whorls, the third forming the suprasutural margination; a fourth appears on the penultimate whorl, and 19 or 20 on the last, with one or two fainter ones between; the first two are feebler and closer set than the rest; on the body they are rather distant, on the front of the shell rather stronger and close set. *Colour* a pale buff, but not improbably white when fresh. *Spire* conical, subscalar in consequence of the prominence of the keel. *Apex* is small, rounded, consisting of $3\frac{1}{4}$ carinated, but otherwise perfectly smooth, whorls, which form a short compact little cone, of which the extreme tip is a little obliquely flattened down on one side. *Whorls* 10 in all; there is a drooping and very slightly concave shoulder below the suture; the greatest breadth is at the keel, below which the whorls begin faintly, and with a very slightly convex profile, to contract into the inferior suture; the last contracts rather rapidly into a short conical base, running out into a narrow, straight, somewhat one-sided, and not very long snout. *Suture* invisible but for the marginating threads above and below it. *Mouth* club-shaped, being pointedly ovate above, and running out below into a well-marked canal. *Outer lip* concave below the suture and angulated at the keel; it is convex in its sweep to the edge of the canal, from which it runs direct and obliquely to the rounded and open point of the pillar. In leaving the body it retreats at once to the left to form the rounded sinus, which has an excessively short

upper side, but becomes large (though hardly deep) from the great forward wing-like sweep of its lower margin, whose course is quite independent of the ribs; toward the edge of the canal this curve again retreats to the point of the shell. *Inner lip* is a thin narrow glaze margined with a minute furrow; it is oblique, but scarcely convex across the body, direct on the short pillar, and cut off with a long slope to the point of the canal, its edge being narrow, rounded, and scarcely at all twisted. H. 0·43. B. 0·17. Penultimate whorl, height 0·07. Mouth, height 0·2, breadth 0·08.

This species may be associated with the *P. nivalis*, Lovén, group; for though very unlike in texture of shell and length of mouth, yet the general form and style of ribbing are somewhat similar.

11. PLEUROTOMA (SURCULA) BOLBODES, n. sp. (*βολβώδης*, from its bulbous apex.)

St. 120. September 9, 1873. Lat. 8° 37′ S., long. 34° 8′ W. Pernambuco. 675 fms. Mud.

Shell.—High, narrow, conical, with a large bulbous apex, a contracted conical base, and a long snout; scarcely carinated, ribbed, with spiral threads, an impressed suture, pale buff. *Sculpture.* Longitudinals—the whorls are crossed from suture to suture by ribs, which are a little oblique and not curved; they are narrow, pinched in laterally, and most prominent a little above the middle of the whorls; they do not extend to the base, they are parted by shallow furrows rather wider than themselves; on the last whorl there are twelve, and they increase in number up the spire; those at the top are a little sinuous and crowded. The lines of growth are very faint, except on the base. Spirals—there are about ten rounded prominent threads on each whorl, which stand out with special prominence on the ribs; on the last whorl these continue with very considerable regularity and equality to the point of the shell; in the constriction below the suture they are feeble. *Colour* pale buff, but probably white in the living shell. *Spire* conical, not much contracted; the first regular whorl is exceptionally tall, narrow, and cylindrical. *Apex* is a coarse swoln small bulb of little more than one smooth whorl, which lies very much on one side, with the extreme tip almost bent in under it. *Whorls* 6, high, of slow increase, the last a very little tumid; in the sinus-area they scarcely expand,

but are convex below this point; the base contracts rapidly, and runs out into a longish narrow snout. *Suture* well marked and a little constricted. *Mouth* club-shaped. *Outer lip*, convex and in front direct, it retreats very slightly in its course from where it leaves the body, forming a very small, shallow, and open rounded sinus. *Inner lip* is slightly hollowed on the body; straight on the upper part of the pillar but early cut off it advances with a long-drawn obliquity to the point of the shell. H. 0·32. B. 0·12. Penultimate whorl, height 0·06. Mouth, height 0·15, breadth 0·05.

I doubt whether the only specimen of this species is full-grown, and the mouth is a little chipped; but the lines of growth indicate plainly enough the form of the lip. It may be classed with the *P. nivalis* group.

12. PLEUROTOMA (SURCULA) ISCHNA, n. sp. (ἰσχνὸς, lean.)

St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40°.

Shell.—High, narrow, conical, blunt, with a contracted base and longish snout, little sculpture, strongish, yellowish grey, porcellanous. *Sculpture.* Longitudinals—there are only strongish regular lines of growth, which rise into small tubercles, especially on the upper whorls; between the stronger lines the surface of the shell is delicately fretted with other very minute sharp lines. Spirals—the whorls are faintly keeled above the middle by a spiral thread, which is a little stronger and more prominent than any of the others. Close above the suture is another almost as strong, and which also slightly carinates the whorls; half-way between these is a finer thread, which tends to split into two very fine threads; at the suture, but visible beyond the mouth, is another thread, which here defines the base. The longitudinals rise into very small tubercles as they cross the spirals; but this feature is much strongest on the upper whorls, which are reticulated; on the last whorl it is feeble. Between the keel and the suture lie three very fine, equally parted, threads. On the base and snout are about twelve pretty equal fine threads. *Colour* a faintly yellowish grey. *Epidermis* extremely thin, smooth. *Spire* conical, with an almost unbroken profile, the whorls being scarcely convex. *Apex*—there are barely two embryonic whorls, smooth, globose, not flattened down at the tip, which, however, is

slightly immersed. *Whorls* 7 in all, feebly keeled with a just perceptibly concave line from the suture to the keel, and from the keel to the suture below. Just above the suture there is a slight contraction, which forms a faint superior margination. The last whorl is very slightly swoln; the base is rather rapidly contracted, and is drawn out into a rather long, straight, but not narrow snout. *Suture* distinct, impressed. *Mouth* almost club-shaped, being pointedly oval above, with a longish rather sinuous canal below. *Outer lip* forms a regular curve, till at the canal it becomes flattened and oblique; from the body it retreats at once to form the rather deep, rounded, open-mouthed sinus, from which it advances on a very straight line to the edge of the canal in front, where it bends slowly and slightly backwards; it is throughout open, but not patulous except at the point of the canal. *Inner lip* spreads as a narrow porcellanous glaze on the body and pillar; it is slightly hollowed out on the body, is straight on the pillar, toward the front of which it is cut off with a narrow, rounded, and very slightly oblique edge. H. 0·34. B. 0·09. Penultimate whorl, height 0·05. Mouth, height 0·14, breadth 0·05.

This species is very like *P. emendata*, Monterosato (=*P. Renieri*, Phil., but not really that of Scacchi); but is much narrower, has much finer and differently arranged spirals, which are minutely tubercled, the curved cusps of the old sinuses are much feebler, and the longitudinals between the threads are far less distinct. The apical whorls are much less depressed.

13. Pleurotoma (Genota) didyma, n. sp. (δίδυμος, doubtful.)

St. 23. March 15, 1873. Lat. 18° 24′ N., long. 63° 28′ W. Sombrero Island, St. Thomas, Danish W. Indies. 450 fms. *Globigerina*-ooze.

Shell.—High, mitriform, biconical, ribbed, and with spiral threads; the spire subscalar; the mouth narrow; the sinus very slight. *Sculpture.* Longitudinals—the whorls are crossed by eleven oblique, rather strong, but narrow hunchy ribs, with broad open furrows between *; there are also very fine, close, hair-like lines of growth. Spirals—the suture is not quite closely marginated below by a rather slight thread; the sinus-area below this is formed by a little open concave furrow; below this is a

* These ribs and furrows tend to disappear on the last whorl and they die out on the base.

series of about 20 (on the penultimate whorl about 5) pretty equal rounded threads and furrows—the first is weaker than the rest; the second occupies the edge of the shoulder, and marks the angulation of the whorls there rising (as does also the next thread below) into special prominence in crossing the ribs; towards the extreme point of the shell, beyond the threads above referred to, are three or four smaller closely crowded threads. *Colour* white. *Spire* high conical, scalar. *Apex* broken (but probably blunt and *Mangelia*-like). *Whorls* below the embryonic ones 6–7, of slow and regular increase, short and broad, high but small shouldered, prominent above, and a little contracted below; the last contracts from the keel and forms a perfect cone on to the extreme point. *Mouth* long and narrow, with parallel sides. *Outer lip* forms a right angle almost close up to the body, and just at this point forms a very slight shallow open sinus; below this it advances straight to the extreme point of the shell. *Inner lip* is very slightly concave; a thin layer of glaze crosses the body, but becomes thicker, with a prominent edge, down the pillar, which at its point is twisted, but is hardly oblique. H. 0·38. B. 0·13. Penultimate whorl, height 0·05. Mouth, height 0·2, breadth 0·04.

The destruction of the apex in this specimen is unfortunate; but the form of the shell suggests a tip blunt, rounded, and short, as in *Mangelia*. The Messrs. Adams have defined their subgenus *Genota* as having a deep posterior sinus, a feature which should exclude this species from the group; but since the only two species, *P. mitræformis*, Wood, and *P. papalis*, Reeve (if they be two), which they quote as types of the subgenus, have both a very slight sinus remote from the suture, the present species may be put along with these.

14. PLEUROTOMA (GENOTA) ENGONIA, n. sp. (εγγώνιος, angular.)

(?) St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40°.

St. 232. May 12, 1875. Lat. 35° 11′ N., long. 139° 28′ E. Off Inosima, Japan. 345 fms. Sandy mud. Bottom temperature 41°·1.

Shell.—Fusiform, biconical, with an expressed rounded keel angulating the whorls, and a broad, prominent, lop-sided snout.

Sculpture. Longitudinals—there are no ribs. The lines of growth are strong, hair-like, unequal, and close-set; on the keel which marks the line of the old sinuses they are exceptionally strong, prominent, regular, and a little remote, as they also are at the top of the whorls in the suture; still they are throughout rounded, not sharp. Spirals—the whorls are angulated about the middle, and project in a rather narrow, prominent, rounded keel, which is almost crenulated by the lines of growth. The whole surface is also covered by small, broadish, rounded, close-set spiral threads, which are somewhat granularly tubercled below the keel. On the left side of the point of the snout they tend to become obsolete, as they also do on the earlier regular whorls. *Colour* porcellanous white. *Epidermis*: only one minute fragment remains, which seems thin, yellowish, and membranaceous. *Spire* high, subscalar, typically conical, the profile-lines being very little interrupted by the carinal projection. *Apex* blunt, rounded, consisting of two smooth globular whorls. *Whorls* 8, short, broad, of regular increase, the last rather large; they have a sloping, slightly concave shoulder; their profile below the keel is straight and scarcely contracted. At the top of each whorl there is a slight collar, which gives the effect of a very slight canaliculation to the suture. The base of the shell is somewhat swollen, and prolonged into the shortish, broad, and very unequal-sided snout, which lies quite on one side of the base. *Suture* strong and slightly canaliculated. *Mouth* large, almost rhomboidally pear-shaped, sharply angled above, and with a broad open canal below. *Outer lip*, very regularly curved throughout; its edge, which is thin and sharp throughout, retreats at once on leaving the body, forming an open V-shaped sinus, which is rounded at the angle; below this it sweeps downwards and very little forwards, forming a very low-shouldered wing; towards the lower part of the mouth it curves very regularly backwards to the point of the pillar. *Inner lip*, which is polished and porcellanous, is rather broadly excavated in the substance of the shell; it is scarcely convex on the body, very slightly concave at the junction with the pillar, which is narrow and short, being very obliquely truncate in front, with a fine, but strong, sharpish twisted edge. H. 1·26. B. 0·52. Penultimate whorl, height 0·23. Mouth, height 0·6, breadth 0·34.

I have marked the specimen from Station 169 with a query. It is very much rubbed; but the sculpture of the shell, and even of

the sinus-scars, is perfectly preserved. This and the proportion and form of the successive whorls are similar, though the line of keel lies a little higher, the shoulder is squarer and shorter, while the line from the keel to the suture is longer. Were the localities of the two less distant and dissimilar, I would not hesitate. Still the depth at which they live may secure similar conditions for the species even from 35° N. to 37° S.; and in any case I do not feel able to part the specimens.

In its expressed keel this very remarkable shell recalls the young of *P. tornata*, Dillw., or of *P. circinata*, Dall. In form it is slightly like *P. spirata*, Lam., or *P. obesa*, Reeve. The resemblance most striking of all, however, both in form and sculpture, is one to which my attention was kindly drawn by Dr. H. Woodward—that, viz., to *P. cataphracta*, Brocchi, a fossil from the Upper Miocene of the Vienna basin and Northern Italy (Brocchi, ii. 221, no. 52, viii. 16, Lam. ix. p. 367, and Philippi, Enum. Moll. Sicil. i. p. 199, ii. p. 171). Compared with that species, this New-Zealand form is slimmer, the angulation of the whorls is less, but the keel on the angulation is more prominent though less nodulous and much lower placed, and the sinus is more remote from the suture and is sharper.

15. Pleurotoma (Genota) atractoïdes, n. sp. (ἀτρακτοειδής, spindle-shaped.)

St. 210. January 25, 1875. Lat. 9° 26′ N., long. 123° 45′ E. Philippines. 375 fms. Mud. Bottom temperature 54°·1.

Shell.—Fusiform, biconical, very slightly and bluntly angulated, with a scarcely convex base, elongated into a largish, slightly reverted, rather equal-sided snout. *Sculpture.* Longitudinals—there are no ribs; but the close-set, hair-like lines of growth, at nearly regular intervals over the whole surface, rise into thread-like folds which score the shell rather markedly. Spirals—near the bottom of each whorl there is a slight keel on the line of the old sinus-scars; it includes two, bluntly rounded, close-set threads, which are crenulated by a series of small squarish tubercles which, being arranged in pairs, one on each thread and placed one above the other, form short little bars; they are parted by furrows broader than they. There are about forty of these bars on the last whorl, becoming more irregular towards the mouth: on the penultimate whorl there are about fifty; but they again diminish in number on the upper whorls. Answering to these is another

double row at the top of the whorls immediately below the suture; only in these the under thread is more prominent, and has rounded tubercles, while the upper thread is scored by longitudinally narrow sharpish little bars; between these infrasutural threads and the carinal threads the slightly concave surface is scored by four finer threads set with little white nodules. Of these, the second thread from above is the strongest, and its nodules are rhomboidal. Below the keel the whole surface is scored by distinct rounded threads, which rise into little nodules where crossed by the stronger lines of growth; the intervals between these are more than double the width of the threads; they rather increase in distinctness forwards; two groups of three and then one by itself have finer threads, like shadows, in the intervals below them. *Colour* porcellanous white, with a buff apex and a faint tinge of suffused buff on the body, especially in the sinus-scar and within the mouth; the nodules stand out pure white. *Spire* high and perfectly conical. *Apex* $1\frac{1}{2}$ small, rounded, globular, brownish-buff coloured, embryonic whorls, of which the first is a good deal turned up on one side. *Whorls* 10, slightly keeled and banded, conical, broad, short and of very regular increase; the last rather large, long, scarcely tumid on the base, gradually produced into a large, conical, rather equal-sided snout, which is obliquely cut off from the point of the pillar backwards towards the outer lip, and which has a slight twist toward the right. *Suture* slightly canaliculated, from the thickening of the infrasutural collar, behind which it is a little sharply cut in. *Mouth* long and narrow, sharply angulated above, scarcely contracted below, and with hardly any canal in front; there is a slight tinge of buff within. *Outer lip* very sharp and thin and a little contracted, except just toward the end of the canal, where it becomes slightly patulous; its course is an angulated curve, steep above and long-drawn below. On leaving the body, it retreats very slightly and almost straight to the rather distant, bluntly rounded, large, open, and rectangular sinus; from this point its edge forms an almost semicircular curve to the point of the shell. *Inner lip* is hollowed rather deeply into the substance of the shell, which forms a raised edge outside of it; it is narrow on the body, rather broad on the pillar. The line across the body and down the pillar is very little concave. The pillar is long and narrow, running out to a sharp point, which has a fine, rounded, and slightly twisted edge, but can scarcely be said to be in the least degree obliquely cut off.

H. 1·4. B. 0·53. Penultimate whorl, height 0·2. Mouth, height 0·85, breadth 0·3.

This is a peculiarly beautiful species, singular in the breadth of its form, but very much more in the extreme regularity of its biconically fusiform shape. It recalls in an extraordinary way *Conus dormitor*, Solander, an Eocene fossil from the Barton beds of the Hampshire basin, and the cone-like *Pleurotomas* of that formation, such as *P. prisca*, Sol., *P. amphiconus*, Sow., *P. conoïdes*, Sol., and *P. biconus*, Edwds. Dr. H. Woodward says it is near *P. ventricosa*, Lam. ix. p. 372, a Grignon fossil, with which I have not had an opportunity of comparing it during the transfer of the Geological collections from the British Museum to Kensington.

16. Pleurotoma (Drillia) pyrrha, n. sp. (πυῤῥὸς, tawny.)

St. 233 a. May 16–19, 1875. Lat. 34° 35′ N., long. 135° 10′ E. Kobi, Japan. 8–50 fms. Mud.

Shell.—High, narrow, conical, with a longish, somewhat contracted, conical base running out into a largish snout, obliquely ribbed, and covered with spiral threads; the suture is slightly constricted. *Sculpture.* Longitudinals—there are on the last whorl thirteen, on the first regular whorl eight, oblique, rounded ribs, which are obsolete at the top of the whorls, extend to the lower suture, but die out on the base; they are parted by shallow rounded furrows, rather wider than they are: the lines of growth are harsh and numerous. Spirals—at the top of each whorl is a slight swelling, carrying two stronger and many feebler flat spiral threads. The sinus-area is scored by fine, but irregular, spiral threads. The whole of the rest of the surface is covered by rounded spiral threads, which are alternately stronger and finer. On the snout the finer ones disappear, and the stronger ones become sparser; the three highest of the stronger ones rise into slight knots on the ribs. Besides all these, the whole surface is delicately and regularly scratched microscopically. *Colour* porcellanous white, very much stained in the interstices of the ribs, and especially on the larger spiral threads, with tawny or light chestnut-colour, which is also seen on the point of the pillar and canal. *Spire* high and conical, its profile-lines somewhat broken by the angular prominence of the ribs and by the rounded constriction of the suture. *Apex* broken. *Whorls* 10 (remaining), of regular rather rapid increase, short, contracted above, expanding below, angulated by the pro-

jection of the ribs, but otherwise scarcely convex. The last is small, contracting from the top of the ribs, slightly constricted on the base, with a largish conical snout, which is slightly bent to the left, and is very unequal-sided; the point is scarcely reverted. *Suture* linear, lying in a very slight groove, but strongly defined by the marginal swelling below, and by the contraction of the profile-lines above. *Mouth* buff and white coloured within, rather small, pear-shaped, angulated at the upper point, and prolonged into the rather wide and open canal below. *Outer lip* is very slightly concave above, freely convex in the middle, and straight at the canal. It is hardly patulous; the line of its edge advances straight at first, then retreats towards the left, forming a rather large, shallow, open, rounded sinus, from which it runs out rather slowly into a projecting curve, scarcely retreating till it reaches the end of the canal. It is thin throughout. *Inner lip* is smoothly excavated in the thickness of the shell and is rather broad; in its direction it is shortly and slightly concave above, scarcely oblique and quite straight on the pillar, the point of which is obliquely truncated with a sharp twisted edge. H. 1·2. B. 0·45. Penultimate whorl, height 0·19. Mouth, height 0·5, breadth 0·21.

This species belongs to that large and variable group which gather round the *P. Griffithii*, Gray, the synonymy and individual species of which alike require revision. When the group obtains this revision, it is very possible that the 'Challenger' species, and not a few others, will be reckoned as mere varieties. In the meantime I cannot unite it to any species I know. It has a much smaller body-whorl than *P. Griffithii*, Gray. Compared with *P. zonata*, Rve., the sculpture and the proportion of height to breadth throughout the whorls is very different, the growth is shorter, and the pillar has not the twisted band at the point. It is much smaller than *P. Kaderleyi*, Lischke, from Japan, is also narrower in proportion, and is differently banded. Than *P. lanceolata*, Rve., which is also a Japanese species, *P. pyrrha* is much stumpier; it has spirals on the whole surface, not excepting the ribs (a characteristic feature on which v. Martens dwells in his admirable figure and description of Reeve's species in the 'Conch. Mitt.' i. p. 39, viii. p. 4); it has a much larger and proportionally much shorter mouth. Of course if it prove to be a young shell, some of these differences would be accounted for.

It has some resemblance to *P. paretoi*, Mayer (Journ. de

Conch. 1868, p. 110, pl. ii. fig. 2), an Upper Tertiary fossil from Piedmont; but is much thinner, somewhat stumpier, with a smaller apex and more tumid body-whorl.

17. Pleurotoma (Drillia) paupera, n. sp.

St. 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ 30″ E. Aru Island. 800 fms. Mud. Bottom temperature 39°·5.

Shell.—Fusiform, biconical, shortly and feebly ribbed, smoothish, with a slightly constricted suture, of a yellowish-buff colour. *Sculpture.* Longitudinals—above the middle of each whorl is a row of tubercles, which stand out on the upper whorls rather sharp and rounded, but on the lower whorls are elongated into slight, oblique ribs, which tend to become obsolete on the last whorl, and do not extend to the base. They are parted by shallow rounded furrows, which are a good deal broader than the ribs. There are about thirteen of these on each whorl; they do not extend in the least to the sinus-area above the tubercles. The surface is very closely scored with coarsish lines of growth. Spirals —the line of the tubercles forms a rather acute carination, of which there is hardly a trace in the curve of the whorls themselves. The whole surface is covered with harsh, unequal, irregular, flatly rounded threads, which are cut into small coarse granulations by the lines of growth; this sculpture is most developed on the base and snout, less so in the sinus-area, least so of all on the rib-area. *Colour* buff below the yellow *epidermis*, which is coarse and harsh, but not thick; the surface of the shell below it is smooth and free from the granulated texture, but is curiously reticulated by minute interrupted wrinkles, whose course is at right angles to the lines of growth. *Spire* high and conical; its profile-lines are little interrupted by the contraction of the suture. *Apex* eroded in all the specimens. *Whorls* 10–11(?), of regular, rather rapid increase, shortish, with a largish, sloping, but hardly concave shoulder above and a very slight contraction below. They are angulated by the projection of the line of tubercles, but are otherwise little convex; the last is a little tumid and considerably elongated, a little contracted on the base, and gradually drawn out into the conical, straight, longish, and at the end smallish snout. *Suture* rather deep, and strongly marked by the angle at which the superior and inferior whorls meet. *Mouth* buff-coloured within, rather long and narrow, pear-shaped, pointed above, with a longish, broad, and open canal below: the direction is very

little oblique. *Outer lip* curves pretty equally from its origin to the edge of the canal, from which to the point of the snout its course is nearly straight: on leaving the body it retires at once, but very slightly and regularly, so as to form the shallow and openly rounded sinus, from which it advances with a long and regular sweep to the front of the mouth, and then curves slowly backward to the point of the snout: it is thin throughout; above it is straight, but lower down a little patulous. *Inner lip* spreads rather broadly across the pillar, highly polished, buff-coloured, with a slightly raised edge; it is very little concave above, straight, but rather short on the pillar, which is cut off to a long fine point, with a blunt, rounded, very slightly twisted strongish edge. H. 1·75. B. 0·68. Penultimate whorl, height 0·26. Mouth, height 0·85, breadth 0·45.

This species has a vague general resemblance to *P. sancti-johannis*, Sm., from Japan; but that is not ribbed, and has a much longer mouth. Judging by the figures (see Lischke, Japan M. Conch. pt. 3, p. 22, pl. i. fig. 1, and Weinkauff in Mart. & Chem. Conch. Cab. p. 51, xi. 5), it is a good deal like *P. Kaderleyi*, Lischke, but is smaller, considerably less elongated, and very different in colour. It has a very considerable resemblance to two Eocene Pleurotomas, viz. *P. Selysii*, Koninck, and *P. nodulosa*, Lam., between which it occupies somewhat of an intermediate place. Than *P. Selysii* it is stumpier in the spire, shorter in the pillar, and, especially in the upper whorls, more angulated. Than *P. nodulosa* it is much larger, each whorl is much higher, the body-whorl is much longer and narrower, and, especially in the young shell, is much more contracted in the base.

MOLLUSCA OF H.M.S. 'CHALLENGER' EXPEDITION.—Part IX.

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Fam. PLEUROTOMIDÆ (*continued*).

PLEUROTOMA, *Lam.*

18. *Pleurotoma* (*Drillia*) *gypsata*, n. sp.
19. *P.* (*D.*) *brachytona*, n. sp.
20. *P.* (*D.*) *fluctuosa*, n. sp.
21. *P.* (*D.*) *bulbacea*, n. sp.
22. *P.* (*D.*) *spicea*, n. sp.
23. *P.* (*D.*) *ula*, n. sp.
24. *P.* (*D.*) *stirophora*, n. sp.
25. *P.* (*D.*) *phæacra*, n. sp.
26. *P.* (*D.*) *tmeta*, n. sp.
27. *P.* (*D.*) *incilis*, n. sp.
28. *P.* (*D.*) *sterrha*, n. sp.
29. *P.* (*Crassispira*) *climacota*, n. sp.
30. *P.* (*Clavus*) *marmarina*, n. sp.
31. *P.* (*Mangelia*) *subtilis*, n. sp.
32. *P.* (*M.*) *levukensis*, n. sp.
33. *P.* (*M.*) *eritmeta*, n. sp.
34. *P.* (*M.*) *hypsela*, n. sp.
35. *Pleurotoma* (*Mangelia*) *acanthodes*, n. sp.
36. *P.* (*M.*) *corallina*, n. sp.
37. *P.* (*M.*) *macra*, n. sp.
38. *P.* (*M.*) *incincta*, n. sp.
39. *P.* (*M.*) *tiara*, n. sp.
40. *P.* (*Rhaphitoma*) *lithocolleta*, n. sp.
41. *P.* (*R.*) *lincta*, n. sp.
42. *P.* (*Thesbia*) *eritima*, n. sp.
43. *P.* (*T.*) *translucida*, n. sp.
44. *P.* (*T.*) *corpulenta*, n. sp.
45. *P.* (*T.*) *platamodes*, n. sp.
46. *P.* (*T.*) *dyscrita*, n. sp.
47. *P.* (*T.*) *monoceros*, n. sp.
48. *P.* (*T.*) *papyracea*, n. sp.
49. *P.* (*T.*) *brychia*, n. sp.
50. *P.* (*T.*) *pruina*, n. sp.

18. PLEUROTOMA (DRILLIA) GYPSATA, n. sp.

St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40°.

Shell.—Strong, fusiform, biconical, scalar, shortly, sharply and obliquely ribbed, keeled, constricted at the suture, with a long and rather inflated body-whorl and a largish snout. *Sculpture.* Longitudinals—on each whorl is a strongish angulation, forming a shoulder, crowned by a series of narrow elongated tubercles or short ribs; this coronated keel lies on the earlier whorls below, but on the later above the middle. The ribs do not reach the lower suture; in shape and breadth they are irregular, but are always somewhat swollen in the middle and pinched up into prominence; they are parted by flat open furrows of nearly double their width: on the body-whorl they extend very little below the shoulder, and still less above it. There are about twenty of these ribs on the

last whorl, and fifteen on each of the earlier whorls. The surface is scored with hair-like lines of growth, of which every here and there, and especially on the base in the continuation of the riblets, one is stronger than the rest. Spirals—the carination at the shoulder is made more prominent by the sharp line of tubercles. The whole surface is covered with flatly rounded threads, which are roughened by the incremental lines: these threads are strongest on the snout, feeble on the body, and very faint in the sinus-area. *Colour* whitish under a yellowish *epidermis*, which is a rough but thin and persistent membrane. *Spire* high, scalar, conical. *Apex* eroded, but evidently small. *Whorls* 10 (?), of rather rapid increase, high, angulated, with a long, rather high, and scarcely concave shoulder, and with a straight slight contraction to the lower suture; the last is very large in proportion to the rest, being long and somewhat tumid, and ends in an elongated, broad, unequal-sided snout. *Suture* very slight indeed; for though it is defined by the contraction of the whorls above and below, yet the inferior whorl laps up on the one above it so as almost to efface the junction-angle. *Mouth* pale buff-coloured within, long and narrow, angulated above, also at the keel, and also, very slightly, at the junction of the pillar and the body. *Outer lip*: from the body to the keel it is slightly concave and contracted; from the keel it curves very regularly to the point. On leaving the body the line of the edge runs quite straight forward for a short distance, and then curves round to the right, running out on the line of the ribs into a high shouldered prominent wing, between which and the body-whorl the broad, deep, and rounded sinus lies: towards the front of the mouth it retreats rapidly to the point of the snout. *Inner lip* spreads rather broadly on the body, is a little thickened, and has a very slightly raised edge. The pillar is long, straight, narrow, and has in front a slightly twisted edge, but is not truncated. H. 1·75. B. 0·75. Penultimate whorl, height 0·3. Mouth, height 0·96, breadth 0·47.

It is unfortunate that this very interesting species is represented by only two dead and somewhat broken shells.

Dr. H. Woodward, who kindly examined this species for me, says it is near *P. rostrata*, Solander. That species is figured by Edwards in the 'Eocene Mollusca,' published by the Palæont. Soc., p. 218, xxvi. 8. Compared with that figure, this is much stumpier, more scaler, more sharply keeled, and the spiral sculpture

is very much weaker; but there is a great deal of affinity in the general features of the shell.

19. Pleurotoma (Drillia) brachytona, n. sp. (βραχύτονος, short.)

St. 191. September 23, 1874. Lat. 5° 41′ S., long. 134° 4′ E. Off Aru Island, W. of Papua. 800 fms. Mud. Bottom temperature 39°·5.

Shell.—Short and broad, biconical, angulated, thin, with small oblique riblets and spiral threads, and with a lop-sided, small-pointed snout. *Sculpture.* Longitudinals—on the last whorl there are about twenty small, short, oblique riblets which are obsolete on the base; they are parted by shallow furrows somewhat broader than they: they are more numerous and sharper on the upper whorls, where they occupy the whole lower third of each whorl. Immediately below the suture there is a minute collar of very small, short, sharp, irregular puckers with intervals of twice their own breadth: springing from these puckers and coinciding with the riblets are hair-like lines of growth, which are slightly stronger than the rest, which closely cover the whole surface of the shell. Spirals—there is a slight collar at the top of the whorls, which forms a very minute and irregular shelf on the underside of the suture; about two thirds down the whorls is a blunt angulation where the longitudinal riblets rise. Besides these, there are on the whole surface flatly rounded threads which are broad, coarse, and irregular on the base, crowded and narrow at the keel, broader, but faint and more regular, on the shoulder. *Colour* alabaster-white. *Spire* irregularly conical. *Apex* eroded. *Whorls* 8, making allowance for the eroded apex; they have a long, sloping, slightly concave shoulder, a blunt angulation about two thirds down, and below this are nearly cylindrical: the fifth whorl enlarges somewhat disproportionately; and the last whorl is swollen, with a sharper angulation than the rest; the base is convexly conical, and is produced into a lop-sided, centrally situated, small-pointed snout. *Suture* small but distinct, being slightly channelled by the minute horizontal shelf formed by the edge of the infrasutural collar: there is a very slight contraction of the whorls into it. *Mouth* rather small, rhomboidally pear-shaped, being pointed above, prolonged into the rather short and broad canal below, and having a blunt angulation in the outer lip and at the base of the pillar. *Outer lip* very thin: it is somewhat

rectilinearly curved; its edge, on leaving the body, retreats immediately to the left to form the shallow rounded open sinus which occupies the shoulder below the suture. Below this it advances with a long oblique forward slope in the line of the riblets, and then, from about the middle, retreats on a very regular curve to the point of the pillar. *Inner lip* is a thin glaze with a defined edge; it is very narrow on the body, but spreads round the pillar; it is convex on the body, with a bluntly angular concavity at the base of the pillar, which is short, small, conical, unequal-sided, obliquely cut off in front, with a narrow rounded twisted edge. H. 0·61. B. 0·3. Penultimate whorl, height 0·1. Mouth, height 0·31, breadth 0·19.

This is a peculiar form, stamped essentially with the characteristics of a frigid-water species.

20. Pleurotoma (Drillia) fluctuosa, n. sp.

St. 149 d. January 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 38 fms. Mud. Var. cariosa, *W.*

St. 151. February 7, 1874. Lat. 52° 59′ 30″ S., long. 73° 33′ 30″ E. Heard Island. 75 fms. Mud.

Shell.—High, broadish, conical, with a shortish conical base, a slight angulation near the top of the whorls, very oblique ribs, rather thin, white. *Sculpture.* Longitudinals—below the sinus-area narrow, close-set ribs make their appearance so abruptly as almost to count for tubercles; they bend very obliquely to the right, and correspond with the lines of growth with which the surface is closely puckered; on the base they coalesce and become faint, disappearing wholly on the snout. There are twenty-three on the last whorl; in number, but hardly in size, they diminish up the spire rapidly; the hollows between them are about as broad as the ribs. Spirals—in the sinus-area, and between the ribs where the epidermis is preserved, there are fine, sharp, close-set, minute hair-like threads, somewhat fretted by the lines of growth; on the summit of the ribs these also appear, reticulating the surface, but are less distinct; below the sinus-area there is an angulation arising almost entirely from the prominence of the rib-ends. *Colour* dull porcellaneous white below the pale yellowish-grey *epidermis*, which rubs off all the prominent parts of the shell. *Spire* conical, but with its profile-lines much broken by the contraction at the sutures; its upper part is small and rather cylindrical. *Apex* globose, round, comprising two embryonic whorls, the extreme

tip of which is somewhat obliquely flattened down. *Whorls* 8 to 9, rather short, the last a little ventricose; between the suture and the angulation they are a little hollowed; below the angulation the profile-line is convex with a slight contraction into the suture, so that the breadth at the angulation and at the suture is equal. The last whorl contracts rather rapidly on the slightly convex base into a short conical snout, which on the right is so obliquely truncated that it hardly projects, the curve of the lip passing on almost without interruption to the point of the pillar. *Suture* distinct, both from the curve of the whorls and from being itself a little impressed. *Mouth* obliquely oval, pointed above, and with a short broad canal below. *Outer lip* thin; in the sinus it is slightly thickened and very shortly reverted; in its course it forms a semicircular curve, a little contracted inwards in the middle, but at the canal slightly patulous. It scarcely retreats in the slightest degree at the sinus, which is round, open, shallow, and close to the body; below it the lip-edge advances straight (*i. e.* with little forward curve), but with considerable obliqueness, to the edge of the base, from which point it curves backwards to the canal, the edge of which is thin and patulous but not reverted. *Inner lip* is thinly excavated in the substance of the shell, and is very narrow; concave above, it advances straight down the shortish, conical, small, but strong-pointed pillar, which has a narrow, but blunt, and scarcely twisted edge. *Operculum* small, triangular, with a blunt terminal apex; it is pale straw-coloured, and is slightly corrugated with unequal furrows following the lines of growth, some of which lines on the pillar-margin are slightly laminated. H. 0·9. B. 0·36. Penultimate whorl, height 0·16. Mouth, height 0·4, breadth 0·19.

In general form this is like *P. Studeriana*, v. Mart., from Kerguelen; but the breadth of the whorls lies at a much higher point in each, the concave furrow below the suture is wanting in that species, the ribs here are finer and sharper, more crowded and more oblique, and the apex is smaller and more cylindrically prominent. *P. patagonica*, v. Mart., is also like; but in that the snout is much narrower and longer, the sinus is deeper and more remote from the suture; the ribs, which in form are similar, are shorter, much less oblique, and die out on the penultimate whorl; and the whole surface is much more strongly cancellated. In sculpture and form of sinus it is somewhat like *P. fuegensis*, E. Sm. In the specimen from St. 149 D, which I attri-

bute to a var. *cariosa*, the concave furrow below the suture is almost absent, and the aspect of the shell is somewhat different; but both these features are perhaps a mere deception of the eye caused by the rubbing down of the ribs, which are much wasted.

21. Pleurotoma (Drillia) bulbacea, n. sp.

St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40°.

Shell.—Broadish, conical, sharply keeled, with a shortish contracted base and a short snout, short narrow ribs, and spiral threads, a bulbous apex, strong, porcellaneous. *Sculpture.* Longitudinals—below the sinus-area and about one third down the whorl from the suture arise, not quite abruptly, ribs slightly tubercled at the top, straight, direct, narrow, and parted by shallow furrows about twice their breadth; they become feeble toward the lower suture; on the last whorl they do not continue to the base, and become broader and weaker toward the mouth: there are eleven on the last and penultimate whorls; on the first infraembryonic whorl there are about seventeen, crowded, sharp, scarcely curved and oblique. The lines of growth are numerous and unequal; in the sinus-area they are sharp and delicate, on the rest of the shell coarse and puckered. Spirals—marginating the suture at the top of each whorl is a narrow scarcely swollen band; below this the sinus-area is very finely, almost microscopically, scratched; and this scratch-sculpture is continued, though less distinctly, on the rest of the surface. The projection of the top of the ribs forms a sharp keel. The rib-area is crossed by five coarsish threads, which rise into small tubercles on the ribs; one or two smaller threads come in between the lines of these spirals. The same sort of threads, but less distinct, are found on the base; those on the pillar and snout are a little more distinct. *Colour* dull porcellaneous white. *Epidermis* quite gone. *Spire* rather short, conical, very slightly scalar, cylindrical toward the top. *Apex* two smooth embryonic whorls, swollen and roundedly pressed down, with a deepish suture, rather more prominent than the regular whorl which follows. *Whorls* 6½, short, of rather rapid increase; the last large relatively to the rest; from the suture to the ribbing they are concavely shouldered. The projection of the tubercles at the top of the ribs forms a carination,

which does not really exist in the form of the whorls themselves: there is a very slight contraction towards the lower suture. The last whorl contracts slightly from the keel to the edge of the base, and from that point rapidly to the small, narrow, straight, and direct snout. *Suture* coarse, slightly impressed, and well defined by the band below it. *Mouth* narrowly oval, pointed above, with an oblique, short, rather open and gradually contracted canal in front. *Outer lip* a rather depressed convex curve, a little concave at the top and flattened toward the point: on leaving the body it retreats at once, forming a shallow, blunt V-shaped sinus, from the lower side of which, with little of angulation, it advances very straight to the edge of the canal, whence it slowly curves backward round the open point of the snout. *Inner lip* spreads as a very narrow porcellaneous glaze; it runs very obliquely to the base of the shortish narrow pillar, below which point it is a very little hollowed. The point of the pillar is cut off with a very slight obliquity, and has a blunt and very slightly twisted edge. *Operculum* small, oval, smooth, with hair-like striæ, apex terminal, colour pale brownish yellow. H. 0·5. B. 0·23. Penultimate whorl, height 0·1. Mouth, height 0·24, breadth 0·12.

The blunt apex, the ribs, and coarse spirals of this species suggest some faint affinity with the *P. nivalis*, Lovén, group; but it is very remote.

22. Pleurotoma (Drillia) spicea, n. sp.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Short and broad, biconical, scalar, angulated, without ribs, but with tubercles at the angle, and feeble spiral threads on the base; the snout is small and lop-sided. *Sculpture.* Longitudinals—there are none but very fine, unequal, hair-like lines of growth. Spirals—immediately below the suture is a minute collar of very small, high, round, remote tubercles, whose sutural surface at right angles to the axis is perfectly flat; this collar is strongest on the earlier whorls; below this is a sloping, flat, or slightly concave shoulder. A little above the middle of the whorls is a rectangular angulation beset with small, remote, slightly elongated, sharpish tubercles, which give the appearance of a sharply expressed keel; of these tubercles there are about

twenty-seven on the last whorl; but they diminish rapidly up the spire. The base of the last whorl is defined by a small rounded thread, which forms a feeble keel; it lies quite below the origin of the outer lip. A little remotely below it lie two or three others, rather weaker, but prominent, widely parted, rounded threads, with four or five similar ones on the snout, of which the last one or two are stronger than the others. *Colour* polished porcellaneous white. *Spire* scalar and stumpily conical, with its profile-lines much interrupted by the constriction of the sutures. *Apex* consists of two embryonic whorls; it is large and dome-shaped, having the extreme tip quite immersed and the suture almost suppressed. *Whorls* 5½ in all (but the specimen is immature); they are short and broad, of rather rapid increase, with a broad horizontal shoulder and a sharp carinated angle, below which they are cylindrical with a slight contraction to the lower suture; the last is broadest at the keel, a little contracted below this point, tumid on the base, drawn in at the pillar, with a small, short sharp-pointed snout. *Suture* very strong and distinct, from the concave curve of the whorl above it and the horizontal tabulation of the collar below. *Mouth* largish, angularly pear-shaped. *Outer lip* thin, angulated, straight and horizontal above, convex and patulous below the angle, drawn in at the snout; it retreats at once on leaving the body to form the rather deep, narrow, rounded sinus which occupies the shoulder; below this it descends very little, but runs out into a very convex curved edge, whose prominence is greatly increased by the rapidity and extent of the retreat of the lip-edge at the snout. *Inner lip* is narrowly excavated in the substance of the shell on the body and down the pillar; it has a convex contour across the body, at the junction of which and the pillar is a strong but rounded angle; the pillar is short, strong, conical, obliquely truncated in front, with a sharp, rounded, twisted edge. H. 0·25. B. 0·16. Penultimate whorl, height 0·04. Mouth, height 0·14, breadth 0·09.

The largest specimen of this species seems somewhat immature.

23. Pleurotoma (Drillia) ula, n. sp. (οὖλος, crisp.)

St. 169. July 10, 1874. Lat. 37° 34′ S., long. 179° 22′ E. N.E. from New Zealand. 700 fms. Grey ooze. Bottom temperature 40°.

Shell.—Rather short, fusiform, biconical, scalar, angulated, obsoletely ribbed, with rather strong spiral threads. The snout is rather short, broadish, and lop-sided. *Sculpture.* Longitudinals—there are on the last whorl about 18, very oblique, curved, narrow, rather obsolete, irregularly arranged riblets parted by wider shallow furrows; they originate faintly at the suture, are strongest and somewhat mucronate at the angulation, extend to the lower suture, and appear on the base, but not on the snout; they are much stronger on the earlier whorls than on the last one. There are very many fine hair-like lines of growth. Spirals—there are a great many remote hair-like threads; on the shoulder below the suture these are fine and closer-set than on the body and base; the carinal one at the angulation and that next below this, especially the first, are strong; they are ornamented with close-set, round, minute granules, which swell into small prominent tubercles in crossing the riblets; those on the carinal spiral in particular are high, sharp, and horizontally elongated. In the interstices of the ribs and spirals the whole surface is microscopically granulated: it is this granulated surface which gives the peculiar crisp aspect to the texture of the shell, from which its name is taken. *Colour* semitransparent flinty, white, with a crisp or slightly frosted aspect. *Spire* scalar, rather stumpily conical, with its profile-lines much interrupted by the constriction of the sutures. *Apex*: there are two globose embryonic whorls, of which the first is immersed, but scarcely flattened down on one side; they are rather remotely microscopically regularly striated. *Whorls* 5½ in all; they are short, broad, of slow increase, with a rather long sloping shoulder and a sharp carinated angle, below which they are cylindrical, with a very slight contraction to the suture; the last is broadest at the keel, and from this point convexly contracted to the rather short, broadish, conical snout. *Suture* linear, but well marked by the contraction of the whorls. *Mouth* rather large, rhomboidally pear-shaped, with three angles above, and prolonged below into a wide open canal. *Outer lip* thin, angulated, rectilinear above to the keel, flatly curved below; on leaving the body it at once retreats to the left, forming in the shoulder a shallow, open, rounded sinus; below the angle it advances very little; and at the snout its retreat is small. *Inner lip*: there is a thin narrow glaze on the body and pillar; at the base of the pillar is a slight rounded angle: the pillar is short, conical, and straight; its point is very slightly truncate,

with a narrow, rounded, but scarcely twisted edge. H. 0·24. B. 0·117. Penultimate whorl, height 0·04. Mouth, height 0·12, breadth 0·06.

This shell may very likely be immature. The external lip in *Pleurotoma* is generally so thin that it is difficult to determine from it when the shell is full-grown.

24. Pleurotoma (Drillia) stirophora, n. sp. (*στειροφόρος*, keeled.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Pernambuco. 350 fms. Mud.

Shell.—High, narrow, with an elongated conical base, longish pillar, and a blunt apex, angulated, obsoletely ribbed, tubercled, thin, polished, flinty white. *Sculpture.* Longitudinals—the lower half of the whorls is crossed by obsolete, rounded, oblique, straight ribs, with very slight rounded depressions between; there are about twelve, of increasing indistinctness, on the last whorl, and nine on the first regular whorl; they take their origin in a row of small, round, sharpish tubercles; they do not extend to the base. The lines of growth are faint sharpish scratches, and are quite independent of the ribs. Spirals—a little above the middle each whorl is angulated and carinated, the carinal thread being set with small, sharpish-pointed tubercles, in which the longitudinal ribs originate. The sinus-area is smooth; the rest of the surface is marked by very obsolete, depressed, rounded threads. *Colour* greyish transparent white. *Spire* high, narrow, conical; its profile-lines but little interrupted by the broad, shallow, sutural depression which extends from keel to keel of the successive whorls. *Apex* consists of nearly 2 embryonic whorls, which are cylindrical, quite smooth, and end in a perfectly rounded tip, which is slightly immersed, and scarcely, if at all, oblique. *Whorls* 7, short, and of slow increase; they are angulated above the middle, with a drooping, scarcely hollowed shoulder above, and a very slight contraction of their straight line below; the last is small, rapidly contracted on the conical base, and running out into a somewhat one-sided, and slightly twisted, narrow, longish snout. *Suture* little oblique, linear, a little disturbed by the longitudinal ribs; well defined by the superior and inferior slope of the whorls. *Mouth* club-shaped, oval above, with a longish, open, rather oblique canal. *Outer lip* thin, with a flattened convex curve, which is steepish at the shoulder and elongated at the canal; on

leaving the body it sweeps at once to the left, leaving a very narrow shelf between the body-whorl and the sinus, which is rounded, rather shallow and open, but large, from the very considerable forward sweep of the pinion-like edge of the lip as it approaches the canal, from which it retreats toward the point of the shell. *Inner lip* is a thin-glazed, narrow, slightly depressed area; it is very slightly hollowed at the base of the longish, finely conical pillar; the point of the pillar is cut off with a long-drawn obliquity, and has a fine, slightly twisted edge. H. 0·3. B. 0·1. Penultimate whorl, height 0·05. Mouth, height 0·13, breadth 0·06.

This species resembles *P. syngenes*, W., in general character of its whorls and style of its sculpture; but its longitudinal ribs are a marked feature of difference. It is, besides, a much narrower shell, with a larger apex, a much smaller body, and a less contracted base with a much shorter pillar. Its weaker sculpture and slimmer form distinguish it at once from *P. lophoessa*, W. In shape it is very like *P. ischna*, W., and *P. bolbodes*; but these are in sculpture and in texture unlike it and one another.

25. Pleurotoma (Drillia) phæacra, n. sp. (*φαίακρος*, dun-tipped.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Pernambuco. 350 fms. Mud.

Shell.—High, conical, with a blunt, dun apex, a contracted base, a longish pillar; angulated, tubercled, thin, polished, glassy. *Sculpture.* Longitudinals—there is no other longitudinal sculpture than the fine scratch-like lines of growth. Spirals—toward the bottom of each whorl is a row of about twelve round, blunt-tipped, rather prominent tubercles, which form an angulated keel where otherwise there is no carination; there is also a slight blunt keel round the base: the surface is covered with very obsolete, rounded, flat threads. *Colour* polished glassy white, with a hyaline dun apex. *Spire* high, rather narrow, conical; its profile-lines little interrupted by the carinal tubercles. *Apex*: there are about two glossy, dun-coloured, globose, embryonic whorls; the extreme tip is rounded and slightly bent down on one side. *Whorls* 6, short, and of slow growth, with a longish, drooping, somewhat concave shoulder, angulated below the middle by the row of tubercles, and slightly contracted into the inferior suture.

The base, which is a good deal contracted, is conical, and runs out into a fine longish snout. *Mouth* club-shaped, being somewhat pointedly rhomboidal above, with a longish canal below. *Outer lip* thin, with a pretty regular convex curve, which is flattened at the summit, and prolonged in a straightish line at the canal; on leaving the body it retreats at once to the left, leaving a very small shelf above the sinus, which is shaped like an open U with diverging margins: toward the lower part of the mouth the lip runs out in a pinion-shaped projection, retreating thence to the point of the pillar. *Inner lip* thin and narrow, little concave, with a long sharp-edged truncation of the point of the pillar. H. 0·18. B. 0·08. Penultimate whorl, height 0·03. Mouth, height 0·08, breadth 0·03.

The only specimen of this beautiful little species is not full-grown. It is broader in form and finer in the apex than *P. bolbodes*, W., or any other of that group, of which it most resembles perhaps *P. strophora*, W. Possibly in a more developed condition it may in form approach more nearly to *P. fluctuosa*, W., from which its sculpture entirely removes it.

26. Pleurotoma (Drillia?) tmeta, n. sp. (τμητὸς, furrowed.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—A mere fragment of two whorls, but with very marked features. It is evidently high and narrow, with short and numerous whorls, which are sharply but broadly angulated very much above the middle; the shoulder above the angulation is scored by very many sharp curved threads, the scars of the old sinus; the rise of these forms a collar below the suture, which is thus distinct. The angulation is raised into a keel by rounded tubercles, which are the origin of narrow, curved, very oblique ribs, of which there are twelve on the last whorl; they extend to the base, but not to the snout, which is very small and short. The whole surface is closely scored by fine, rounded, spiral threads. The sinus of the outer lip is separated from the body by a narrow shelf, and is shallow, rounded, and open on the underside, where the convex shoulder of the lip lies very low. The narrow inner lip has a small pad above, is rather oblique and concave in the middle; the front of the pillar is very slightly truncated obliquely, and has a sharply rounded and hardly twisted edge. The mouth

is long, narrow, and oblique. H. (?). B. 0·128. Mouth, height 0·14, breadth 0·039. Penultimate whorl, height 0·078.

27. Pleurotoma (Drillia) incilis, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra, island of St. Thomas, Dan. W. Indies. 390 fms. Coral-mud.

Shell.—Fusiform, narrow, finely ribbed and spiralled, with a high, conical, subscalar, fine-pointed spire; a short conical base produced into a small, narrow, triangular snout. *Sculpture.* There are fine sharpish riblets parted by furrows of twice their breadth, which run pretty continuously with a slight dextral twist from whorl to whorl; there are about eighteen or twenty on the last whorl, and fewer on each preceding whorl; they are a little oblique, and on the base sinuous; they originate below the sinus-area and run down to the inferior suture; on the base they become finer and more crowded, and gradually die out without reaching the snout; the lines of growth are shown by fine close-set scratches. Spirals—immediately below the suture there is a broadish depressed band constituting the sinus-area, only marked by the lines of growth; this band at the top of each whorl gives the scalar appearance to the spire: below this is a slight raised border, where the longitudinal ribs arise; and here there is an angulation of the whorl, which is sharp and median on the upper whorls, but is less so on the last. Close below the border of the sinus-area is the first spiral thread, a series of which, fine, rounded, little raised, cover the rest of the shell, rising into small knots on the riblets; of these threads there about two on the earlier whorls, four on the penultimate, and about nine or ten on the last, exclusive of those on the snout, of which there are about nine; of these the highest are a little stronger, and the following ones a little more crowded than the others. The whole surface of the shell is microscopically granulated. *Colour* dead white. *Spire* high, narrow, conical, subscalar. *Apex* consists of four conical embryonic whorls rising to a minute rounded point a little bent over to one side; they have a sharp expressed keel and a broad, slightly impressed suture. *Whorls* 11, rather short, of very regular increase; they have a sloping, slightly sunken shoulder, below which they have a slight angulation, which is made prominent by the swelling of the riblets and the spiral thread which connects these; from this point, which lies rather above the middle,

the whorls contract gradually downwards till just at the lower suture, where there is a very slight sudden constriction. The last whorl is small, contracting from the keel, with a pinch in toward the point at the base, which is produced into a narrow, slightly elongated, triangular snout. *Suture*: there is a small narrow depression in the bottom of the open constriction of the whorls. *Mouth* oblique, narrow, pear-shaped, slightly angulated above, and produced below into a narrow canal. *Outer lip* thin and sharp, but strengthened by a remote, rather prominent though narrow labral varix: it is only slightly curved on the profile of the shell; but the lip-edge advances in a very high prominent shoulder, between which and the body lies the narrow, rounded, gutter-like sinus, with a prominent reverted outer edge all round. *Inner lip* slightly thickened above; it is thin on the body, but is thicker again on the pillar, on which it advances very direct, with a slightly raised edge, but does not reach the point of the shell, the pillar being cut off with a long, oblique, narrow, twisted edge, which advances along the side of the canal beyond the thin callus of the pillar. H. 0·57. B. 0·21. Penultimate whorl, height 0·09. Mouth, height 0·25, breadth 0·8.

This species considerably resembles *P. amœna*, E. Sm., from New Zealand; but that species has not so scalar a spire, its base and canal are longer, and its apex is blunt.

28. Pleurotoma (Drillia) sterrha, n. sp. (στεῤῥὸς, solid.)

Sept. 8, 1874. Flinders Passage, off Cape York, Torres Strait. 7 fms.

Sept. 8, 1874. Cape York, off Albany Island. 3–12 fms.

Shell.—Very strong, high, narrow, conical, with a subconical base, strongish, rather crowded ribs, and small spiral threads, variegated in colour. *Sculpture.* Longitudinals—the whorls are crossed by rather straight ribs, which are rather strong than high; they extend to the base, but not to the snout; they are dislocated at the top, and are not continuous from whorl to whorl: there are about twelve on the last two whorls; but they diminish rapidly in number up the spire: every here and there one becomes somewhat varicose; on the base they become flexuous, and tend to bifurcate; they are parted by narrow and shallow furrows: the lines of growth are fine and crowded, but on the top of the ribs they tend to cut the surface into coarsish tubercles. Spirals—below the suture is a broadish but superficial constriction, which is

the sinus-area, and is occupied by the dislocated tops of the ribs; these become on the upper whorls more and more a slightly prominent tubercled string-course below the suture; this band is cut off by a slight furrow from the true top of the ribs, which project here a little angularly. The whole surface is closely beset with spiral threads and furrows; of these threads that at the suture is broadish but depressed; below it is another stronger. On the body and base are about ten accompanied by one or sometimes two very small ones. The furrows are broadish, square, and flat in the bottom; on the snout are three or four; and on the twisted cord in front there are five. *Colour*: a narrow band above the suture and the sinus-area below are of a deep rich buff, which extends to the whole base, intensifying to a rich ruddy orange on the snout and pillar; the ribs are white, but except on the snout their interstices are dark purply brown. *Spire* very regularly conical and high. *Apex* consists of about $2\frac{1}{4}$ very small, conically tapering, embryonic whorls, parted by a very fine suture, and rising to a minute rounded tip, which is very much bent down on one side. *Whorls* 13 in all, conical, barely convex, and hardly angulated near the top; they are short and broad, of very regular slow increase; the last is small, and contracts quickly but not deeply, with a rounded base prolonged to a broad conical snout which is obliquely cut off in front, with a twist, which forms a sort of slight cord across the point. *Suture* slightly impressed, distinct. *Mouth* small, narrow, pear-shaped, rather sharply pointed above, with a longish, curved, rather narrow, and open canal in front, which runs down the massive snout, and is patulous, till at the very point the edge is slightly inverted. *Outer lip* broken: the sinus lies about $\frac{1}{20}$ of an inch below the suture, from which it is separated by a strong shelf of that breadth and about $\frac{1}{10}$ inch long; it is deep, rounded, and narrow, being shut in by the high shoulder into which the outer lip projects below it; orange-coloured, through which the dark bars shine. *Inner lip*: there is a small but thick and narrow pad above; below, it is reverted on the pillar, and has a raised edge; in front it is not bent back again, but runs down to the point with a prominent sharp edge: the pillar is rather short, strong, not broad, conical, sharp-pointed, not twisted, and not cut off obliquely, as usual, from the right of the shell towards the left, but, on the contrary, from the left to the right; and here the projection of the lip-edge leaves a small, shallow,

umbilical furrow. *Operculum* typical, having the nucleus apical and being curved; thin, rather strongly marked with the lines of growth, and having on its outer face a small, prominent, but not thickened bank or rising in the middle from end to end. H. 1·42. B. 0·45. Penultimate whorl, height 0·23. Mouth, height 0·6, breadth 0·24.

The specimen of this fine species obtained from off Albany Island is full-grown, and is very markedly broader than the other; but in all other respects they are identical. Otherwise like *P. interrupta*, Lam., in form, it has a longer pillar. It has some resemblance in shape to *P. rosaria*, Reeve, but in all details is most distinct.

29. Pleurotoma (Crassispira) climacota, n. sp. (*κλιμακωτὸς*, scalar).

St. 172. July 22, 1874. Lat. 20° 58′ S., long. 175° 9′ W. Inside the reef, Tongatabu. 18 fms. Coral.

Shell.—Strong, biconical, with a high, pointed spire, and a short, lop-sided, but truly conical base, reticulated with ribs and spirals, and with a constricted band below the suture. *Sculpture.* Longitudinals—there are about 15 or 16 rather narrow, sharpish ribs on each whorl, with intervening furrows of rather greater breadth; they cross the whorls with very little obliquity from suture to suture, and on the last extend to the very point; a few of them bifurcate on the base; the lines of growth are very slight. Spirals—below the suture is a band about $\frac{1}{12}$ of an inch high, which constricts the upper part of the whorl to the breadth of the base of the one above; this forms the sinus-area: below this is a shoulder on which the ribs project. There are about sixteen or seventeen rounded spiral threads, which are feeble in the furrows, but rise into small rounded tubercles on the ribs; they are parted by shallow flat furrows of about the same breadth: of these spiral threads there are four on the penultimate whorl; and they diminish in number up the spire. The whole surface is very finely spirally striated; and there are microscopic granulations besides. *Colour* white. *Spire* very regularly conical, but distinctly scalar from the angular projection of the shoulder. *Apex* somewhat worn, but small, apparently consisting of two conical, rounded, embryonic whorls with a fine sharp suture. *Whorls* 10 in all, rather high, of very regular and slow increase, angulated by the constriction and the shoulder below it. The

upper whorls are cylindrical below the shoulder; but the body-whorl contracts almost at once, and on the base does so very rapidly and with very straight lines, so that this whorl is very small. *Suture* very small and faint. *Mouth* small, narrow, elongatedly oval. *Outer lip* broken: the sinus lies close up to the top of the whorl, and is small, round, and deep. *Inner lip*: there is a small thick pad above; but below it is thin, narrow, slightly turned back on the straight pillar; but toward the point it is turned again forward on the edge of the blunt and hardly twisted lip. H. 0·63. B. 0·26. Penultimate whorl, height 0·13. Mouth, height 0·25, breadth 0·11.

In form, though broader, this species a good deal resembles *P. Barkliensis*, H. Ad.; but in all details it is unlike. In form it slightly resembles *P. harpularia*, Couth.*, but has the base less elongated and more pinched in, the whorls more cylindrical, and the whole shell more spindle-shaped, with coarser, stronger, and fewer spiral threads, forming tubercles on the ribs. It is not unlike *P. granularis*, E. Sm., B. M., but has narrower, sharper, and more widely parted ribs and a more conical spire.

30. Pleurotoma (Clavus) marmarina, n. sp. (*μαρμάρινος*, gleaming like marble.)

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Biconical, with a high pointed spire, a short lopsided base, and a very short snout, ribbed, barely tubercled, with spiral furrows, and a compressed band below the scarcely impressed suture. *Sculpture.* Longitudinals—there are on the last whorl 15 rather narrow, spread-out, rounded, scarcely oblique direct ribs, which begin at the upper suture and extend to the base, but not to the snout; near the top they are cut by a spiral furrow, so that the upper part of them forms a series of small rounded tubercles just below the suture; below the spiral furrow the ribs are slightly swoln into knots; the ribs are parted by wider shallow furrows: these ribs and furrows run pretty regularly down the spire; but there are fewer of them on the earlier whorls. The whole surface is further scored by almost microscopic regular hair-like lines of growth, which are specially sharp in the sinus-area. Spirals—there is a furrow near the top of the

* I copy this note as I made it in the Berne Museum; but I cannot at present ascertain what species of Couthouy this is.

whorls, which constricts both the ribs and the interstices. On the last whorl there are 18 or 20 shallow and narrow furrows parted by flat interstices of about three times their width; these do not extend to the sinus-area, and only very doubtfully to the snout, where there are rather a few irregular and scarcely raised rounded threads: these furrows are not recognizable on the earlier whorls. The whole surface is very delicately fretted with almost microscopic, crisp spiral striæ whose course is not quite regular, and which are crimped or disturbed by the lines of growth; this sculpture is particularly sharp and distinct in the sinus-area. *Colour* pure marble-white. *Spire* very regularly conical. *Apex*: there are about two embryonic whorls, which are small, nearly cylindrical, with scarcely appreciable suture, and end in a blunt, round, laterally flattened-down tip. *Whorls* 10 in all, rather short and broad, scarcely at all convex; the last is large, being broad and tumid, but not long, with a tumidly conical lop-sided base, ending in a short, broad, flat snout which is abruptly and straight cut off. *Suture* linear, but well defined by the swelling of the infrasutural row of tubercles. *Mouth* oval, with an acute angle above, an obtuse angle at the side where the body and pillar join, and a truncation at the point. *Outer lip* thin, a little patulous, with an equable convex curve throughout: the sinus is very shallow and round, with no shelf above it; and below it is a very high but little prominent shoulder made by the very slightly advancing lip-edge. *Inner lip* very narrow, shallowly hollowed into the substance of the shell; the pillar is straight, conical, and is obliquely cut off in front with a blunt, rounded, scarcely twisted edge. H. 0·66. B. 0·29. Penultimate whorl, height 0·12. Mouth, height 0·3, breadth 0·14.

This is a singularly beautiful species, which approaches *P. sacra*, Reeve, but has no semblance of an umbilical chink; the body is broader, the base more contracted, the spire more regularly conical and not at all convex; the individual whorls are much shorter, the sinus much shallower; the colour is pure white, not brown-banded; and the sculpture is deeper and less superficial.

31. Pleurotoma (Mangelia) subtilis, n. sp.

St. 122. Sept. 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—Very small, conical, sharp-tipped, with a lop-sided base, subscalar, ribbed, and with spiral threads; there is a strong labral

varix with a small, deep, round sinus. *Sculpture.* Longitudinals—there are on the last whorl about thirteen rounded, rather weak, slightly oblique longitudinal ribs which extend to the snout; on the fifth and sixth whorls they are fewer, but rather stronger; on the fourth whorl they are lamellar; they are parted by shallow open furrows of fully two-thirds their breadth. The whole surface is covered with microscopic but coarse hair-like lines of growth. Spirals—there are 25 to 30 close-set, flatly rounded, alternatingly stronger and weaker spiral threads, of which those on the shoulder and base of the last whorl are the weakest; those (twelve in number) in the middle of the body are broadest; those on the snout are the most prominent, especially the highest three; of the group on the body, the highest which comes in below the sinus-area forms a very slight keel to the whorls. *Colour* buff. *Spire* subscalar, high, conical. *Apex* consists of $1\frac{1}{2}$ embryonic whorls, which rise regularly to a high, fine, rounded point, the extreme tip of which is quite prominent. *Whorls* 7, of regular increase, high and rather narrow, very slightly carinated, convex; the last is long and narrow, nearly cylindrical in the middle; on the right side the base is scarcely contracted; but on the left side it is cut off with a long, oblique, and very considerable truncation, and is in this way very lop-sided. *Suture* not deep, but distinct and impressed. *Mouth* long and narrow, with nearly parallel sides; the short open canal is of the same width and direction as the mouth itself, and ends in a rather deep nick; the sinus above is about half the width of the mouth, from which it turns off through the thick lip very obliquely, and is funnel-shaped. *Outer lip* in direction oblique and almost straight, a very little inflected, thick, its front face roundly bevelled off to the inner side, and its two sides parallel; it is strengthened by a strong external rounded varix, which extends to the front of the very short snout but not to the pillar; internally there is a slight pad faintly scored by very obscure teeth, but terminating in a single, small, rounded, and rather prominent tubercle on the lower side of the sinus. *Inner lip* very narrow and thin, but with a thickened pad between the sinus and the body-whorl; its direction is oblique, a little concave; above it is very straight on the pillar. H. 0·152. B. 0·06. Penultimate whorl, height 0·028. Mouth, height 0·078, breadth 0·019.

This species resembles a good deal a very small and refined *P. rugulosa*, Phil., having the same lop-sided base; but that spe-

cies has the right side of the base somewhat more obliquely truncated; so that there is much less of inequality between the two sides than in the 'Challenger' species, which is also slimmer, has the sculpture both of ribs and spirals very much finer, the apex much smaller and higher, the suture less deep, and the nick of the canal in front very much more distinct.

32. Pleurotoma (Mangelia) levukensis, n. sp.

July 29, 1874. Levuka, Fiji. 12 fms.

This species extremely resembles *P. septangularis*, Mont., in general appearance and in sculpture, both as regards ribs and the fine spiral striæ. In form it is smaller, narrower, and much more cylindrical, the body-whorl is similarly tumid; but it and the mouth still more are shorter; the penultimate whorl is very much smaller and especially is narrower; while the upper whorls are broader, and the apex very much broader and blunter. The specimen is in too bad condition for detailed description.

H. 0·22. B. 0·1. Penultimate whorl, height 0·04. Mouth, height 0·09, breadth 0·038.

33. Pleurotoma (Mangelia) eritmeta, n. sp. (ἐρίτμητος, well cut.)

St. 75. July 2, 1873. Lat. 38° 38′ N., long. 28° 28′ 30″ W. Off Fayal, Azores. 450 fms.

Shell.—Small, rather narrow, biconical, continuously ribbed, microscopically spirally striated, with a very blunt tip, a rather fine but expressed labral varix, and a very slight shallow sinus which does not cut through the lip. *Sculpture.* Longitudinals—there are eight narrow, rounded, prominent, direct, very slightly oblique ribs, which run continuously from apex to point of base; there are also very faint scratches in the lines of growth. Spirals—the whole surface is very delicately fretted with microscopic, regular, sharpish spiral striæ. *Colour* warm yellowish-white, with a ruddy band below the suture. *Spire* regularly conical. *Apex* consists of rounded, globose, smooth whorls, of which the tip is broken. *Whorls* 6 remaining, of regular but rather rapid increase, rather high and narrow, just perceptibly convex; the last is small, very little tumid, with a short, conical, lop-sided base, ending in a very short, flattish snout, crossed by the longitudiual ribs. *Suture* linear, scarcely impressed. *Mouth* very small and narrow, with almost parallel sides, narrowed above into a small narrow sinus, which cuts only halfway through the thick outer lip; the

canal in front is deep, turning in behind the pillar; it is nearly as broad as the mouth, and is abruptly cut off in front. *Outer lip* very slightly convex, a very little inflected, thick, with a very small projecting sharp inner edge and a prominent narrow pinched-in external varix, which extends to the extreme point but not round the snout; it is half cut through at the very top by the sinus, which, however, does not show itself on the front of the lip; but at this point the whole lip-edge retreats a little and rises slightly on the body-whorl. *Inner lip*: there is a minute pad at the top; but all the rest of it is very thin: in its direction it is a very little oblique; its edge in front is narrow, rounded, and very slightly twisted. H. 0·194. B. 0·087. Penultimate whorl, height 0·039. Mouth, height 0·09, breadth 0·025.

This species somewhat resembles both *P. turgidula*, Forbes, and *P. septangularis*, Mont.; but is slimmer than either of these, the suture is less impressed, and the ribs are much more regular, more continuous, and less tumid in breadth and prominence; the spiral sculpture, too, is *very* much finer, the lines and furrows being much more minute; the mouth, too, is much smaller and narrower, and has not the convex outer lip.

34. Pleurotoma (Mangelia) hypsela, n. sp. (ὑψηλὸς, high.)

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—High, narrow, and conical, with very short whorls, of which there are 6; the last whorl exceptionally small, with a short conical base and very small snout; the suture very slight, but extremely oblique; the apex blunt and rounded; there are narrow, high, rounded, curved, and very oblique ribs, which run continuously from the apex to the point of the base, but not to the snout: there are obsolete spiral striæ, which become stronger on the point of the pillar. H. 0·19. B. 0·067. Penultimate whorl, height 0·033. Mouth, height 0·078, breadth 0·033.

The specimen of this very marked species is in too bad condition for more minute description. It is very like *P.* (*Drillia*) *exilis*, Pease, but is much more attenuated, and the last whorl is much shorter.

35. Pleurotoma (Mangelia) acanthodes, n. sp.

St. 56. May 29, 1873. Lat. 32° 8′ 45″ N., long. 64° 59′ 35″ W. Bermuda. 1075 fms. Grey ooze. Bottom temperature 38°·2.

? St. 75. July 2, 1873. Lat. 38° 38′ N., long. 28° 28′ 30″ W. Fayal, Azores. 450–500 fms. Sand.

Shell.—High and narrow, biconical, ribbed and spiralled, of a frosted-white colour, with subscalar, blunt but small-pointed spire, a small body-whorl and mouth, and rather contracted base. *Sculpture.* Longitudinals—on the last whorl there are 14, on the penultimate 10, and on the first regular whorl 9 ribs: they arise very feebly at the suture, gain height in the sinus-area, and add on a little breadth below; they are high, narrow, and rounded; toward the mouth they are crowded, but in general are parted by rounded furrows of two to three times their width; they extend to the extreme point of the base, but not to the snout. The whole surface is likewise fretted with minute sharp lines of growth. Spirals—on the embryonic whorls there is one, on the other whorls two, fine spiral threads; the upper and stronger lies below the sinus-area about one third down the whorl, and forms, with help of an angulation at that point, a rather sharp keel, rising into small sharp tubercles at the intersections of the ribs; between this keel and the root of the snout there are on the last whorl six weaker threads, which all rise into tubercles as they cross the ribs. On the snout are three or four weaker threads without tubercles: the interstices of these spirals are from twice to four times their width. The whole surface of the shell, except the embryonic whorls, is scored with very fine, sharp, close-set spirals, which, at crossing the lines of growth, are beset with microscopic blunt prickles which give the frosted aspect to the shell. *Colour* white; only the tip is smooth. *Spire* conical, scalar, in consequence of the drooping projecting shoulder at the top of each whorl. *Apex* consists of $3\frac{1}{2}$ embryonic whorls, which are conically globose, smooth, keeled, closely roundedly ribbed, with a deepish suture, and rise to a minute point (crushed). *Whorls* $8\frac{1}{2}$ in all, a little hunchy and disorderly; they have a long slightly drooping shoulder defined by the keel, below which they are cylindrical, with a slight contraction into the lower suture: the last whorl is small, with a contracting scarcely convex base, prolonged into a small, but distinct, and somewhat cylindrical snout. *Suture* small, slightly impressed. *Mouth* small, narrow, slightly pear-shaped, oblique, triangular above, prolonged into the small canal below. *Outer lip* flat at the shoulder, angulated at the keel, slightly convex below this; the edge projects thinly beyond the last longitudinal rib, which serves as a varix: it presents a flat-

tened, but regular, curve from the point of the shell to the keel, where the edge forms a little shoulder, between which and the body lies the narrow round small sinus, with its flanged border. *Inner lip* straight, with a very thin narrow glaze which early runs out to the rim, being cut off by the slightly oblique and twisted edge, which continues with a slight patulous margin to the point of the shell. H. 0·34. B. 0·12 Penultimate whorl, height 0·07. Mouth, height 0·15, breadth 0·04.

The specimen from St. 75 is somewhat broken and rubbed, and is therefore attributed to this species with a doubt; the identity, so far as means of comparison exist, is close, only the individual whorls are a little broader and shorter. *P.* (*Mangelia*) *corallina*, Wats., is so similar, that I classed this at first as a variety of that other under the name *elongata*; but I am now persuaded of their distinctness. In *P. acanthodes* the embryonic apex is narrower, higher, and sharper, with an indefinite junction to the regular whorls; in *P. corallina* it is much more compact, with the whorls more sunken or immersed, broader, and lower, and its junction is very distinctly defined. In *P. acanthodes* there are 3½ embryonic whorls, which are contracted, also minutely tubercled on the keel; and the lower part of the whorls is nearly smooth. In *P. corallina* there are 4 embryonic whorls, which are not keeled and are scarcely angulated, with a very slight contraction into the lower suture; the riblets are stronger, and extend from the upper almost to the lower suture. *P. corallina* is a larger, sharper-cut shell, squarer in its lines; four whorls in it are as long as five in the other, the body-whorl especially being longer and in the base much more elongated and fuller; and the snout is broader.

36. Pleurotoma (Mangelia) corallina, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. St. Thomas, N. of Culebra Island, Dan. W. Indies. 390 fms. Coral-mud.

Shell.—High, narrow, with squarish lines, biconical, ribbed and spiralled, of a frosted-white colour and coral-like texture, with a scalar, blunt but small-pointed spire, a smallish body-whorl, a conical base, and a small undefined snout. *Sculpture.* Longitudinals—there are about 13 ribs on each whorl; but they do not all exactly answer from whorl to whorl; they rise feebly just at the suture, but quickly increase in height, more slowly in breadth; in the sinus-area they are curved; from the

shoulder they are straight, with only a slight curve on the base; they die out on the snout; they are narrow and rounded, and are parted by rounded furrows of three times their breadth: the whole surface is also fretted with sharp minute lines of growth. Spirals—there is a straight, slightly drooping shoulder below the suture; this ends above the middle of the whorl in a distinct angulation defined by a fine thread, which rises into small, sharp, rounded tubercles as it crosses the ribs. On the penultimate whorl a finer thread begins to appear in the inferior suture, but gradually rises above it; it is from this lower spiral that the contraction of the base begins: on the base are 3 or 4 finer spirals parted by spaces about four times their width; then follow several weaker crowded spirals, then one stronger and more prominent; all these rise into small tubercles on crossing the ribs: beyond the end of the ribs, on the snout, are some 6 fine distinct threads. The whole surface between these is closely covered with very fine spiral threads, which on all the longitudinal lines of growth are beset with most orderly and regular microscopic blunt prickles, which give the coral-like aspect to the surface. *Colour* white; the tip alone is smooth. *Spire* conical, scalar. *Apex* consists of 4 embryonic whorls, which are bluntly conical, depressed, rounded, ribbed, with a distinct suture, and rise to a minute tip (crushed). *Whorls* 8 in all, broad and short, of regular increase, sharply keeled at the shoulder-spiral, and from this very slightly contracted, but altogether angular, not curved: the last whorl is small, but attenuated, not constricted, is scarcely convex on the base, and is produced into a short, vaguely defined, and very obliquely pointed snout. *Suture* very slight, but defined by the angulation at which the whorls meet. *Mouth* small, narrow, slightly pear-shaped, very little oblique, bluntly triangular above, and prolonged into the short, open, scarcely narrowed canal below. *Outer lip* flat at the shoulder, angulated at the keel, scarcely convex below this; the edge projects as a thin sharp lamina beyond the last longitudinal rib, which serves as a varix from the point of the shell to the keel; the edge is hardly convex, and scarcely forms a shoulder above, the sinus being merely a small rounded hollow. *Inner lip*: the glaze is exceptionally narrow and short; the curve of the lip is a very little concave at the base of the pillar, which is rather longer and narrower than one would expect, and which is cut off in front with a long, slightly oblique, bluntly rounded, twisted edge. H. 0·32. B. 0·13. Penultimate whorl, height 0·08. Mouth, height 0·16, breadth 0·06.

This and *P. acanthodes* are extremely alike; but one easily notices the relatively shorter and broader form and the squarer outline and ribbing of this. Under that other I have mentioned a number of features of difference which, though individually minute, concur in marking the distinction of the two species. A comparison of this species with *P. nuperrima*, Tib., = *P. decussata*, Phil. (not = *P.* (*Raphitoma*) *hispidula*, Jan, which is certainly distinct *), suggested by Dr. Gwyn Jeffreys, I was enabled to obtain through the kindness of the Marquis de Monterosato. *P. corallina* resembles that other in the minute blunt prickles which are found on many corals, and which ornament the spirals; but the 'Challenger' species is far smaller and narrower, the last whorl in particular is very much shorter and less tumid, the whorls are always more angular, the spirals are fewer, the longitudinal ribs are both fewer and stronger, and the apex is utterly different both in form and sculpture.

37. Pleurotoma (Mangelia) macra, n. sp. (μακρὸς, long.)

St. 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W. West of the Azores. 1000 fms. *Globigerina*-ooze. Bottom temperature 39°·4.

St. 78. July 10, 1873. Lat. 37° 26′ N., long. 25° 13′ W. Off San Miguel, Azores. 1000 fms. *Globigerina*-ooze.

Shell.—High, narrow, biconical, fragile, translucent white, glossy, feebly ribbed and spiralled, with a stumpy subscalar spire, ending in a large, conical, sculptured, sharp-tipped dome, and with a small body-whorl, contracted base, and produced snout. *Sculpture.* Longitudinals—there are on the last whorl about 20 flexuous oblique threads; they rise at the suture, retreat very much to the left in the sinus-area, but at the angulation below this they curve round to the right and die out on the base; the flat intervals which part them are three times their breadth; the system of longitudinal ribs on the embryonic whorls is very much like that of the shell, but is really different: the lines of growth are very fine, and are quite independent of the ribs. Spirals—below the sinus-area there is a blunt angulation strengthened by

* The minute ornamentation of the surface in these two species is very similar, and is apt to mislead; but the form of the whorls and the details, both of longitudinals and spirals, are different The embryonic whorls, too, are distinct, being in *P. nuperrima* broader and more pressed down; the sculpture is diverse also, the longitudinal ribs being the prominent feature in *P. nuperrima*, while in *P. hispidula* it is the spirals.

a row of small tubercles on the ribs. The surface is covered with very obsolete broadish threads, which are crowded on the body, but on the base are stronger, more regular, and wider apart; on the snout they are finer and more crowded. The suture is marginated below by a flat thread. *Colour* almost papyraceous white. *Spire* is subscalar, narrow, and would be high but for the abruptness with which it is crowned by the *apex*, consisting of four yellow conically globose whorls, of which the last is large and dome-shaped, and the first minute, prominent, but at the very tip slightly bent down; the first two are smooth; the last two are sparsely crossed by minute cusp-like threads or riblets. *Whorls* 7 to 8 in all, rather high, with a drooping shoulder in the sinus-area, which is defined by the angulation below; below this the upper whorls are nearly cylindrical, while the body-whorl barely convex: this whorl is small; on the base it is a little contracted and drawn out, and is produced into a small and rather lop-sided snout. *Suture* minute, but impressed and further defined by the marginal thread. *Mouth* small, narrow, pear-shaped, triangular above, and produced below into the relatively broad, open, and deep canal. *Outer lip* flat at the shoulder, feebly angulated at the keel, scarcely convex below; the edge, which is quite independent of the ribs, is very convexly prominent below, with a high and advancing shoulder, above which lies the deep, open-mouthed, rounded sinus. *Inner lip* is exceedingly narrow; it is thinly cut into the substance of the shell, and very early runs out on the slightly oblique, narrow, twisted edge of the pillar, which is straight, narrow, and very slightly angulated at its junction with the body. H. 0·25. B. 0·09. Penultimate whorl, height 0·044. Mouth, height 0·13, breadth 0·04.

Probably none of the specimens obtained of this species are quite full-grown.

38. Pleurotoma (Mangelia) incincta, n. sp.

St. 78. July 10, 1873. Lat. 37° 26′ N., long. 25° 13′ W. Off San Miguel, Azores. 1000 fms. *Globigerina*-ooze.

Shell.—High and narrow, with rounded lines, biconical, thin, white, glossy, feebly ribbed, faintly spiralled and slightly keeled, having a high, stout, conical spire ending in a blunt point, with a small long body-whorl, produced base and snout. *Sculpture.* Longitudinals—there are on each whorl about 22 slight and unequal threads serving as ribs; they are cusped at the top of the whorls,

and oblique below; on the last whorl they are sinuous, but very obsolete: the ordinary lines of growth are excessively faint, except in the sinus-area, where they are sharp though minute. Spirals —the suture is marginated below with a very small, prominent gemmed thread; below the plain suture-area is a slight keel, beset by small tubercles where it crosses the riblets. On the body flat threads are just perceptible, which increase in distinctness on the point of the base; on the snout these become more raised and are parted by intervals of two or three times their width. *Colour* porcellaneous white. *Spire* broadish, conical. *Apex* consists of 4 globose, conical, yellow embryonic whorls, whose point of union with the regular whorls is slightly obscure; the last is rather closely curvedly ribbed longitudinally, while the earlier ones are polished and smooth; the extreme tip is small. *Whorls* 8 in all, rather broad, with a very slight drooping shoulder defined by the tubercled spiral thread and keel which bisects the earlier whorls, but loses importance in all ways further down; below this keel there is a slight gradual contraction into the inferior whorl; the last whorl is very slightly tumid, with a protracted, slightly convex base produced into a narrow snout. *Suture* a little impressed, marginated below by the infrasutural thread, whose upper edge forms a minute horizontal shelf, and which looks as if it girt-in the shell*. *Mouth* long, narrow, pear-shaped. *Outer lip* thin and sharp, steeply curved above, slightly convex below; the edge advances below in a full round sweep; above it forms a prominent, but not very high shoulder, above which lies the open rounded sinus, with a minute triangular shelf formed by the projection of the infrasutural thread, and to a small extent separating the sinus from the body. *Inner lip* narrow, shallowly excavated in the substance of the shell, dying out early in front on the oblique, sharp but rounded, twisted and slightly reverted edge of the pillar. H. 0·5. B. 0·18. Penultimate whorl, height 0·08. Mouth, height 0·28, breadth 0·09.

This species and *P.* (*M.*) *macra*, Wats., belong to a group very peculiar, and evidently numerous in the North Atlantic, as there are young specimens from the same neighbourhood of five other species, evidently all distinct, but stamped strongly with the same features, of a thin glossy shell, obsolete sculpture, a slight gemmate keel, and the peculiar large, conically globose, minute-tipped, smooth, longitudinally ribbed apex.

* Hence the name.

39. Pleurotoma (Mangelia) tiara, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. St. Thomas, N. of Culebra Island, Dan. W. Indies. 390 fms. Coral-mud.

St. 56. May 29, 1873. Lat. 32° 8′ 45″ N., long. 64° 59′ 35 W″. Bermudas. 1000 fms. Grey ooze. Bottom temperature 38°·2.

Shell.—High and narrow, rather strong, white, spiralled, with a high subscalar spire ending bluntly in a small tip, with a very small body-whorl, a short contracted base, and a very short small snout. *Sculpture.* Longitudinals—there are a number of hair-like sinuous lines, which in the sinus-area are like bars; they are parted by flat intervals of about three or four times their width: the lines of growth are very faint. Spirals—there are on each whorl two strong sharp keels which nearly trisect the whorl; the lower of these is sometimes feeble; marginating the suture below is a fine thread; on the base are 8 or 10 sharp and prominent threads of varying and unequal strength; at the upper end of the snout is another strong thread; below this is a little furrow, answering, as in *Cerithiopsis*, to a small nick at the point of the pillar. On the pillar are from two to four more threads of variable strength. *Colour* porcellaneous white. *Spire* high, narrow, conical, subscalar. *Apex* a little bluntly conical, consisting of 4 to 5 whorls, of which the upper ones are small and smooth; the last two are ornamented with minute ribs or elongated bosses. *Whorls* about 10 in all, high and narrow, of very slow and regular increase, slightly convex, with a sloping shoulder, rather cylindrical in the middle, and slightly contracted below; the last whorl is small, very slightly tumid, with a very contracted base and a small subcylindrical snout, the point of which is slightly reverted and nicked. *Suture* very minute and concealed, in spite of the contractions of the whorls and the inferior margination. *Mouth* short, small, and pear-shaped, not narrow, triangularly pointed above, and ending below in the short, rather open canal. *Outer lip* a pretty regular curve; its edge is prominent below with a low shoulder above, leaving a wide funnel-shaped opening for the rather shallow rounded sinus. *Inner lip* very narrow, thin, and short, dying out early on the narrow twisted oblique edge of the pillar, which is slightly reverted along the side of the canal so as to produce a small twisted furrow. The line of junction of the pillar and the body is very concave. H. 0·32. B. 0·11. Penultimate whorl, height 0·07. Mouth, height 0·12, breadth 0·06.

The specimen of this species from St. 56 has the spiral threads very much finer than that from St. 24. The species has a strong superficial likeness to *P. emendata*, Monterosato, $=$*P. Renieri*, Phil., nec Scac.; but that is a broader and larger shell, has a more tumid body-whorl and a longer base; its whorls are not so high-shouldered, are more convex, are not so strongly keeled, are not so deeply and strongly parted by the square impressed suture; and the apex is of the large blunt dome-type, consists of only two whorls, and is simply carinated.

40. Pleurotoma (Raphitoma) lithocolleta, n. sp. (λιθοκόλλητος, gemmed.)

St. 23. March 15, 1873. Lat. 18° 24′ N., long. 63° 28′ W. Off Sombrero Island, St. Thomas, Dan. W. Indies. 450 fms. *Globigerina*-ooze.

Shell.—High, narrow, conical, with a short base and a blunt apex, bluntly angulated and tubercled, thin, smooth, ivory-white. *Sculpture.* Longitudinals—there are none but very fine scratch-like lines of growth; behind and parallel to the lip-edge there are three narrow sickle-shaped ribs, which are probably an accidental feature. Spirals—very slightly above the middle of the whorls runs a feeble angulation set with round but a little narrowed and obliquely elongated knobs, of which there are about 12 on each whorl; on the first regular whorl there are about 10: before the end of the penultimate they have quite died out, and even the angulation of the whorl tends to disappear. There are faint traces of microscopic spirals over the whole shell, rather in the texture than on the surface; these are rather more distinct below the suture; and in the sinus-area there are two faint impressed lines. *Colour* polished ivory-white. *Spire* high, narrow, conical. *Apex*: the $2\frac{1}{2}$ embryonic whorls are cylindrical, quite smooth; and these have the extreme point very much flattened down on one side so as to make a perfectly rounded tip. *Whorls* $11\frac{1}{2}$ in all; they are rather short, and of very regular increase, slightly convex, but not contracted either above or below; the last is a very little tumid with a rounded base, contracting very rapidly to a short broad snout, which is abruptly truncated at the point. *Suture* rather oblique, fine, regular, defined by a slight impression: it rises a very little at the mouth. *Mouth* pear-shaped, small, narrow, little contracted in front. *Outer lip* somewhat thickened, with a small reverted edge in the sinus and at

the point of the canal, but sharp and a little contracted in all the rest of its extent: it leaves the body at a slightly acute angle, and retreats at once obliquely to the left, but very shortly, to form the narrow rounded sinus, from which, almost parallel to the line of the suture (*i. e.* with a very slight oblique direction forwards), it sweeps far out to the right in a great convex-edged wing, retreating again a little to the edge of the very short canal, where it turns a very little and obliquely forwards; the point of the canal is open, and cut off obliquely from the right forwards to the point of the pillar. *Inner lip*: a thin porcellaneous glaze, a little thickened at the sinus, spreads narrowly on the body, which is a good deal excavated; the pillar is straight, short, conical, very little truncated, with a slightly twisted and sharpish edge, and a pretty solid though fine point at the extreme front of the shell. H. 0·65. B. 0·23. Penultimate whorl, height 0·1. Mouth, height 0·22, breadth 0·1.

In style of ornamentation this singularly beautiful species somewhat resembles *P. syngenes*, Wats.; but the differences are so obvious as not to need mention. I do not know any species with which to compare it. *P.* (*Fusus*) *modiolus*, Jan, = *P. carinata*, Biv., has some resemblance; but that is a coarser and broader shell, and has the mouth much larger.

41. Pleurotoma (Raphitoma) lincta, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. Culebra Island, St. Thomas, Dan. W. Indies. 390 fms. Mud.

Shell.—High, narrow, conical, with a blunt round apex, and a short and very contracted base, ribbed, polished ivory-white. *Sculpture.* Longitudinals—there are on the last whorl 11, on the first 9, very short ribs (or elongated tubercles) which do not extend to either suture; they are rounded on the top, are parted by broad rounded furrows, and run obliquely forward from left to right; they sometimes extend to the base: besides these, there are only slight hair-like lines of growth. Spirals—the prominence of the tubercles forms an angulation at about one third of the whorl's height above the suture; there are sometimes a few flatly rounded and feeble threads on the snout. The surface is very delicately microscopically scratched. *Colour* ivory-white and highly polished. *Spire* high, narrow, conical, with profile-lines slightly interrupted by the projection of the tubercles. *Apex* consists of $2\frac{1}{4}$ embryonic whorls, which are small, globose, and

flatly rounded at the tip. *Whorls* 10, short, angulated, but only by the prominence of the tubercles, which also gives the appearance of a sutural contraction; the last is small, with a rounded, very abruptly contracted, conical base, prolonged into a small prominent snout, which is almost imperceptibly bent backward. *Suture* linear, but well marked from the profile-lines of the whorls above and below meeting at a slight angle. *Mouth* pear-shaped, angulated above, and a little produced below. *Outer lip* very regularly curved, but straight along the canal, a little contracted in the middle: on leaving the body it does not immediately bend to the left, thus leaving a narrow but well-marked shelf along the whole upper edge of the rather deep, narrow, rounded sinus, below which it advances into a high-shouldered pinion: it scarcely retreats below this till close to the point of the snout. *Inner lip* is very narrow; it is scarcely convex on the body, and is somewhat angular at the base of the conical pillar, down which it runs with a somewhat thickened, reverted, and prominent edge defined by a small furrow; it is scarcely cut off obliquely in front with a narrow, thickened, rounded edge. H. 0·46. B. 0·16. Penultimate whorl, height 0·07. Mouth, height 0·18, breadth 0·07.

This species a good deal resembles *P. micans*, Hds.; but is a much narrower form, with a higher and finer spire, more numerous whorls, and is not merely tubercled, but has its tubercles prolonged into ribs. Than *P. pudica*, Hds., it is longer, narrower, with a deeper suture, a shorter canal, and a much blunter apex. *P. sigmoidea*, Bronn, is broader, the whorls are longer, the apex is blunter, the body-whorl is much longer, and that species has no open constriction below the suture.

42. Pleurotoma (Thesbia) eritima, n. sp. (*ἐρίτιμος*, very precious.)

St. 135. October 18, 1873. Nightingale Island, Tristão da Cunha. 100–150 fms. Rock, shells.*

Shell.—Very small, but hardly thin, oblong, spirally striated, with a long body-whorl, a rather high conical spire, a blunt round-pointed apex, and a short broad truncated snout. *Sculpture.* Longitudinals—there are exceedingly faint scratches in the

* I have copied for this set of dredgings the note appended to the box which contained them. In the list of stations there is nothing which exactly answers, though in the book of stations issued for the naturalists its place is recognizable.

lines of growth. Spirals—the whole surface is scored with fine narrow impressed furrows, which are about half the width of the raised interstices. *Colour* uniform pellucid ruddy brown, paling towards the point of the snout. *Spire* rather high, but not small, conical, but with convex profile-lines. *Apex*: $2\frac{1}{4}$ embryonic whorls, which rise in a conically globose form to a blunt rounded point with the very small tip, which is immersed and bent down on one side. *Whorls* 5, slightly convex, rather short and broad except the last, which is long and narrow, having a produced, broad, and conical base, ending in a broad undefined snout. *Suture* very slightly impressed in consequence of a faint swelling of the superior and inferior whorls. *Mouth* oblong, pointed above, and broadly truncate below, at the end of the scarcely contracted canal. *Outer lip*, which is a little contracted above and a little patulous below, is a flat curve in both its planes ; the edge projects into a small high-placed shoulder, between which and the body lies the shallow, open, rounded sinus, with a very minute, short, triangular shelf above it. *Inner lip* : there is a thin narrow glaze on the body and pillar; at the junction of these two there is a very slight concave curve ; otherwise the line is very direct and is slightly oblique; the glaze does not extend quite to the point of the pillar, which is scarcely twisted or truncated. H. 0·12. B. 0·049. Penultimate whorl, height 0·03. Mouth, height 0·06, breadth 0·024.

This species is perhaps the one of all the following group which conforms most nearly to the type, *Columbella nana*, Lov., for which Dr. Gwyn Jeffreys suggested the subgeneric name of *Thesbia* (see Brit. Conch. iv. p. 359). I have followed Prof. G. O. Sars in connecting the group with the *Pleurotoma* family, though he will probably find my group a little heterogeneous; and I am unable to follow him in giving it the dignity of a genus, nor can I, in the face of his type, accept "spira breviuscula" as one of its characteristics (Moll. Arct. Norv. p. 221, see pl. xvi. fig. 2).

43. Pleurotoma (Thesbia) translucida, n. sp.

St. 145 a. December 27, 1873. Lat. 46° 43′ 5″ S., long. 38° 4′ 30″ E. Halfway between Marion Island and Prince-Edward Island. 150 fms. Grey sand.

St. 149 b. January 17, 1874. Lat. 49° 28′ S., long. 70° 30′ E. Entrance of Royal Sound, Kerguelen. 30 fms. Mud.

St. 149 d. January 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Animal.—*Foot* fuscous olive, large, thick, square in front,

pointed behind. *Mantle* paler. *Siphon* rather short. *Head* and *tentacles* pale. *Eyes* large and black, on the upper outer side and at about a fourth of the length of the tentacles, which are rather solid, long, and cylindrical; between these, and a little above them, is the large prominent expanded snout, with a large circular opening in front, round which the edge of the snout projects like a thick fleshy fringe. There are two unequal branchial plumes. The radula consists of exceptionally minute, acicular, sharp-pointed, horny prickles. There is no *operculum.*

Shell.—Thin, horny, smooth, oval, with a tumid body-whorl, a rather high, subscalar, small-pointed, round-whorled, shallow-sutured conical spire, and a tumid lop-sided base, pointed at the pillar, but with scarcely any snout. *Sculpture.* Longitudinals—there are close-set fine hair-like lines of growth; under the microscope a system of much finer regular striæ is seen to cover the whole surface. Spirals—there are many fine, irregular, and unequal rounded striæ, which faintly appear on the surface, but are distinct on the pillar and front of the shell: besides these, there are fine microscopic smooth scratches. *Colour* white, with a faint tinge of yellow, horny, translucent, with a smooth and shining, but hardly glossy, surface. *Spire* rather high, conical, subscalar, from a slight bulge of the shoulder. *Apex*: $2\frac{1}{2}$ embryonic whorls, subcylindrically conical, rising to a small, rounded, slightly immersed tip, which is a little bent down on one side. *Whorls* 6 in all; they are rounded, tumid, with a faint subangulation below the sinus-area, in which there is a flattening rather than a constriction of the surface; below the periphery of each whorl the form is cylindrical, with a very slight contraction into the lower suture. The whorls increase regularly, but rapidly; the last is large and tumid, with a protracted rounded base cut off on the left by an oblique, scarcely concave line. There is scarcely any snout, and the shell is truncated obliquely towards the point of the pillar, which projects in a rectangular prominence. *Suture* linear, impressed. *Mouth* very large, lop-sidedly oval, pointed above and below. *Outer lip* a semicircular curve in both planes, leaving a shallow, wide, shortly rounded sinus between the lip-edge and the body. *Inner lip*: a thin, narrow pad stretches very regularly along its whole length (which forms a very regular concave curve) out to the thin, twisted, obliquely truncated edge of the pillar: this edge runs out beyond the labial pad, and forms

a thin sharp margin along the canal. H. 0·51. B. 0·28. Penultimate whorl, height 0·13. Mouth, height 0·32, breadth 0·14.

This species is more like *Thesbia nana*, Lov., than any thing else I know; but besides being very much larger, it has the body-whorl very much longer and more tumid, and the spire very much stumpier.

44. PLEUROTOMA (THESBIA) CORPULENTA, n. sp.

St. 149 *d*. January 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Thin, oval, spirally striated, with a tumid body-whorl, and a rather high, subscalar, small-pointed, round-whorled, shallow-sutured, conical spire, an obliquely conical base, and a slight snout. *Sculpture*. Longitudinals—slight hair-like lines of growth. Spirals—the subsutural sinus-area is very slightly concave, and below it is a slight carinal angulation; the whole surface is covered by fine flatly rounded threads, which are stronger and more remote on the penultimate than on the last whorl. *Colour* white. *Spire* rather high, conical, subscalar. *Apex* small, conical, rounded, with the extreme tip flattened down. *Whorls* 6, rounded, tumid in the middle, and very slightly contracted below into the suture; they increase regularly, but rather rapidly; the last is large, rather tumid at the shoulder, and contracting with considerable equality on either side to a shortly produced conical base, ending in a small, but broadish, snout. *Suture* broadly impressed. *Mouth* large, oval, pointed above, and truncate below at the point of the very short canal. *Outer lip*: a semicircular curve in both its planes: its edge forms a rather high shoulder, between which and the body lies the rather deep, funnel-shaped, rounded sinus. *Inner lip*: a thin narrow pad stretches along its whole length (which forms a regular concave curve) out to the thin, twisted, obliquely truncate edge of the pillar; this edge runs out beyond the thin labial pad, and forms a sharp margin along the canal. H. 0·55. B. 0·31. Penultimate whorl, height 0·1. Mouth, height 0·3, breadth 0·19.

Compared with *P.* (*Thesbia*) *translucida*, Wats., this has a rather higher and narrower spire, the suture is more oblique, and the last whorl, besides being much shorter, is more tumid above and less so below.

45. Pleurotoma (Thesbia) platamodes, n. sp. (πλαταμώδης, flattened.)

St. 149 d. January 20, 1874. Lat. 49° 28′ S., long. 70° 13′ E. Royal Sound, Kerguelen. 28 fms. Mud.

Shell.—Thin, fusiform, very finely spirally striated, with a short tumid body-whorl, a high, small, scalar, small-pointed, round-whorled, shallow-sutured spire, a very oblique and scarcely conical base, and a smallish very one-sided snout. *Sculpture.* Longitudinals—there are very slight unequal lines of growth; and on the lower part of the whorls very slight remote oblique riblets, which entirely disappear on the last whorl. Spirals—fine, very regular and beautiful, sharp, close-set scratchings cover the whole surface. Below the suture a shallow concave trench marks the line of the old sinus; the lower edge of this broad furrow is defined by a slight thread. *Colour* white. *Spire* rather high, conical, scalar. *Apex* small, ending in a flattish, rounded, slightly raised point. *Whorls* 6, of regular, but rather rapid increase, rounded, without any contraction below: above, each laps up rather high and thinly on the whorl above; below this they at once swell out tumidly, but hollowed by a slight concave furrow, from which results the scalar rise of the spire; the last is tumid, but obliquely contracted on the base, and ends in a small triangular snout. *Suture* very slight and not in the least impressed, but well defined by the furrow below. *Mouth* large, oval, pointed above, and truncate below at the front of the very short canal. *Outer lip* a little patulous; in its arch it is a little gibbous above; the curve of the edge is nearly semicircular, with a high prominent shoulder, between which and close up to the body lies the deep, funnel-shaped, rounded sinus. *Inner lip*: a thin narrow glaze crosses the body and advances along the pillar, on which it rather early comes to an end, being cut off by the oblique, curved, and thin edge which runs out to the point of the shell: this glaze is defined by a small furrow on its outer margin. The pillar is rather long and straight. H. 0·4. B. 0·2. Penultimate whorl, height 0·07. Mouth, height 0·23, breadth 0·11.

Compared with *Pleurotoma corpulenta*, Wats., this is a smaller, squatter shell, with a smaller and more scalar spire, whose outlines, too, are more concave; the body-whorl is much shorter and more tumid, and the base is much more contracted. From *P. translucida*, Wats., it differs still more in these particulars. From both in its sculpture it is markedly distinct.

46. Pleurotoma (Thesbia) dyscrita, n. sp. (δύσκριτος, of difficult determination.)

St. 23. March 15, 1873. Lat. 18° 24′ N., long. 63° 28′ W. Sombrero Island, St. Thomas, Dan. W. Indies. 450 fms. *Globigerina*-ooze.

Shell.—Thin, white, narrowly oblong or fusiform, with a longish, scarcely tumid body-whorl, a shortish, conical, convexly whorled, small-pointed, shallow-sutured, conical spire, and a long conical base. *Sculpture.* Longitudinals—there are delicate thread-like curved lines of growth, which are strongest near the top of the whorls. Spirals—the whole surface is equably covered with fine, faintly raised, rounded threads; they are slightly fretted by the longitudinals; between them are little rounded furrows of about twice their breadth. *Colour*: the spiral threads are porcellaneous, the furrows translucent white, and the surface is a little glossy. *Spire* rather short, conical, but slightly concave, with hardly any interruption in its profile-lines by the very slightly impressed suture and convexity of the whorls. *Apex* consists of 2½ rounded subcylindrical whorls rising to a small rounded point, where the extreme tip hardly projects and is bent down on one side; it is smooth and glossy, but retains traces of a ruddy epidermis with minute spiral threads. *Whorls* 6 in all, of regular but rapid increase, rather high and broad, convex, but sloping, and not tumid; the last is very long and full, though not tumid; and there is little contraction on the long conical base. *Suture* slightly impressed, rather oblique. *Mouth* large, open, and oblong, pointed above, scarcely contracted below, but truncated at the end of the broad open canal. *Outer lip*: very equably curved in both its planes; it has a somewhat high and prominent shoulder above, between which and the body-whorl lies the rather deep, wide, rounded sinus. *Inner lip*: a thin glaze on the body and out on the long pillar, which is cut off in front with a long, thin, twisted, oblique edge. H. 0·35. B. 0·16. Penultimate whorl, height 0·8. Mouth, height 0·22, breadth 0·08 (?).

This beautiful little shell, though enclosed in a small glass tube, was found sadly broken, so that the measurement of the breadth of the mouth is slightly doubtful. It is very like *P. fragilis*, Reeve; but in that species the spirals are stronger and more remote, and the longitudinals much sharper. *Defrancia Magellanica*, Phil., is even liker, but is a much stronger shell, has a shorter mouth, below the suture the upper whorls there are contracted

and are not so equably rounded; the apex in that is a little larger, the spirals are more regular and are waved, and are not so much raised, and the longitudinals are much fainter. In *Defrancia supercostata*, E. Sm., the upper whorls are ribbed. What it most resembles, however, is the *Bela* (?) *expansa*, G. O. Sars, who kindly compared the two species and sent me his unique specimen for examination. That is a much longer and narrower shell, of much faster increase, larger in the apex, and higher and narrower in each corresponding whorl; the whole spire is thus much more elongated, and the last whorl is very much less tumid; the shell, too, is thicker, and the whole style of sculpture coarser. In the same length it has about one whorl less. The curve of each of the whorls is more tumid; and as each slopes down to the straighter suture, it slowly and slightly contracts.

47. Pleurotoma (Thesbia ?) monoceros, n. sp.

St. 104. August 23, 1873. Lat. 2° 25′ N., long. 20° 1′ W. S.W. of Sierra Leone. 2500 fms. Mud. Bottom temperature 36°·4.

Shell.—Thin, ivory-white, high, narrow, drawn out, with fine spiral threads, a very oblique impressed suture, rounded whorls, and a contracted base produced into a longish snout. *Sculpture.* Longitudinals—none but fine, somewhat unequal lines of growth. Spirals—with the exception of the sinus-area, the whole surface is covered by fine, rounded, unequal, and irregularly interrupted spiral threads with rather broader intervals. *Colour* porcellaneous, ivory-white, glossy. *Spire* remarkably narrow, high, drawn out and conical. *Apex* broken. *Whorls* 5 remaining, but probably 8–9 in all, of very regular, but rather rapid increase, high, oblique, slightly tumid: the last rounded, with a conical, protracted, but very lop-sided base running out into a longish straight pillar and triangular snout. *Suture* very oblique and rather deeply impressed. *Mouth* pear-shaped, scarcely pointed above, and protracted into a gradually narrowing canal below. *Outer lip* a very regular curve in both its planes; the outer edge has a very high and prominent shoulder, whose upper side runs a long way parallel to the body-whorl above it, having a very deep rather than narrow sinus, between which and the body-whorl is no shelf whatever. *Inner lip* is on the narrow body scarcely perceptible as a glaze; on the long direct twisted pillar it is a little thicker, but is very narrow: the end of the pillar is cut off with a very long-drawn, oblique, slowly narrowing, sharp, twisted edge. H. (of remaining

whorls) 1·03. B. 0·35. Penultimate whorl, height 0·21. Mouth, height 0·49, breadth 0·18.

This very remarkable form, suggestive of the Narwhal's horn, has unfortunately lost its whole apex. If, therefore, I have put it in this group, it is that the whole style of the shell rather suggests this companionship; and at least I prefer to put it here than under *Surcula* or *Defrancia*. It has in form some features of resemblance to *P. aureola*, Reeve, from the Philippines; but, apart from colour, it has a deeper suture and rounder whorls than that.

48. Pleurotoma (Thesbia) papyracea, n. sp.

St. 147. December 30, 1873. Lat. 46° 16′ S., long. 48° 27′ E. Between Prince Edward Islands and Kerguelen. 1600 fms. *Globigerina*-ooze. Bottom temperature 34°·2.

Shell.—Thin, like delicate tissue-paper, white, bluntly keeled, subplicate, with a small, high, sharp, scalar spire, an angulated suture, a short tumid body-whorl narrowing from the carina, suddenly contracted on the base, and prolonged into a largish triangular one-sided snout. *Sculpture.* Longitudinals—there are extremely fine hair-like lines of growth; there are also oblique, rounded, narrow foldings of the surface, which below the sinus-area rise into 14 small, narrow, sparse ridges or elongated tubercles and extend to the base: on the earlier whorls these rise into small thread-like ribs which reach the inferior suture. Spirals—the almost membranaceous sinus-area forms a sloping shoulder below the suture, and occupies about one third of the whorl; below this is the keel, on which the little tubercles rise: from this keel downwards the surface is covered with minute, unequal, but rather regular, though somewhat interrupted, sparse threads with broader intervals: besides this there is a microscopic, obsolete, spiral granulation which extends to the sinus-area. *Colour* alabaster-white, so far as the excessive thinness permits; the small spiral threads are somewhat dead white; the embryonic whorls are of a rich ruddy-orange tint. *Spire* perfectly conical, scalar, high, sharp. *Apex* consists of 3½ ruddy, smooth, embryonic whorls, which are globose, divided by an impressed suture, and rise to a small, blunt, round top, in the middle of which the extreme tip just barely rises into sight. *Whorls* 8½ in all, of slow, but increasingly rapid enlargement; those of the spire are rather narrow and high, and have a high flat shoulder, a sharp angulated keel, and

a very slight contraction from this point to the inferior suture; the last whorl is tumid, but short, with a sloping shoulder, a much blunter angulation, a marked contraction from this point, a very blunt angulation defining the base, which contracts a good deal and suddenly, and which on the right side is prolonged into the conical, triangular-shaped, blunt- though small- pointed snout. *Suture* linear and almost invisible, but well defined by the angulation at which the whorls meet, and also by the change of colour where the inferior whorl laps up on the one above it, which produces a pseudo-margination. *Mouth* large and irregularly semicircular, angulated above, and ending in a distinct open canal below. *Outer lip* excessively thin, slightly patulous below, but not at all above; it leaves the body at a right angle, and advances across the sinus-area in a perfectly straight line; it is angulated at the keel, from which point it curves very regularly, till towards the edge of the canal it becomes concave and finally straight; round the front of the canal it is not in the least patulous: its edge forms a semicircular curve with a high shoulder, between which and the body lies the large, broad, open, rounded sinus. *Inner lip*, which, though very narrow, is continued to the point of the pillar, is cut into the substance of the shell, and is defined by a slight raised margin beyond it; the line across the body is very short, and joins the pillar at a very obtuse angle. The *pillar* is very long and straight, and is cut off in front with a very gradually oblique, thin, twisted edge. H. 1·04. B. 0·52. Penultimate whorl, height 0·2. Mouth, height 0·59, breadth 0·3.

This is a species of the most singular beauty and delicacy, like nothing known to me.

49. Pleurotoma (Thesbia) brychia, n. sp. (βρύχις, from the depths.)

St. 106. August 26, 1873. Lat. 1° 47′ N., long. 24° 26′ W. Mid-Atlantic. Bottom temperature 36°·6. 1850 fms. *Globigerina*-ooze.

Animal.—In colour pale buff with a greenish liver. The mantle is prominent, thin, made up of separate, but connected, threads like a fringe, with a denticulated margin. From within it to the left a great fold of flesh projects, whose drawn-together edges form the anterior siphon; this fold is an extension of the inner side of the mantle close within its edge, which edge expands into a flap to enclose this siphon. On the right the mantle is drawn back and expanded, so as to form an imperfect open channel cor-

responding to the sinus of the outer lip. The body is rather small, cylindrical, protracted into a strong, rounded, abruptly truncate snout, which is probably long when not contracted by the spirit. On either side of the snout, and rather below the middle of its horizontal line, project the tentacles, which are short, cylindrical, and blunt, and have no eyes at any part, either of their base or on their length. The foot is large, being broad and flat, but not high; in front it is broad and square, with projecting rounded corners; behind it is long and pointed. There is no branchial plume; but on the under surface of the mantle is a strong central line with long pectinated fringes extending from it on either side. The cloacal duct does not open in the body, but runs out on the right side in the mantle to a large, longish, thickened nipple, which corresponds with the sinus of the shell. This duct was full of hard oval green pellets. Mr. John Murray, F.R.S.E., kindly examined these for me, and writes:—"In the little pellets I find *Coccoliths*, small *Globigerinas*, *Pulvinularias* and their broken fragments, *Diatoms*, *Polycistinæ*, *Challengerias*, fragments of a Crustacean, and setæ of an Annelid." *Operculum* none.

Shell.—Very short and broad, biconical, subscalar, angulated, very thin, obsoletely ribbed, with spiral threads, and having a longish, lop-sided, small-pointed snout. *Sculpture.* Longitudinals—on the penultimate whorl there are about 20 short, scarcely oblique, small, rounded, little prominent ribs, with shallow rounded furrows between of a like breadth; they only occupy the lower half of the whorls, extending to the inferior suture, but not at all to the shoulder; they diminish rapidly in number up the spire. On the body-whorl they appear only as oblique and slightly elongated tubercles, which coincide entirely in direction with the lines of growth. These are fine, close-set, and hair-like: below the suture they are straight and irregular, forming on the upper whorls infrasutural crenulations; on the body-whorl they rise into slight undulations in prolongation of the ribs, and these continue to the point of the snout. Spirals—there is a blunt angulation about the middle of the whorls; and here the longitudinal ribs take their rise. The whole surface of the shell is covered with rounded threads and furrows: on the shoulder of the whorls these are rather obsolete; on the angle among the tubercles they are strong, but rather crowded; but from this downwards they are very distinct and regular, with a few finer ones interspersed, becoming a little crowded on the snout, and then sparse and

stronger at the extreme point. *Colour* alabaster-white, almost translucent from the thinness of the shell. *Spire* conical, with profile-lines a little interrupted by the contraction of the sutures. *Apex* slightly eroded, but evidently small and rounded; the embryonic whorls seem to be about two. *Whorls* 8 in all, of rapid increase, but that rather in breadth than height; the last is extremely large and tumid; they have a long and gently sloping shoulder above, and are cylindrical below the blunt angulation which bisects them; the last contracts slowly from the angle, and is tumidly convex on the base, the curve of which sweeps on, on the right side, uninterruptedly to the point, while on the left side it passes by a rather deep concave curve into the lop-sided, triangular-shaped, small-pointed snout, which, however, projects very much in the line of the axis. *Suture* strong, a little channelled from the overlap of the calcareous surface of the inferior whorl, well defined from the angulation made by the meeting of the whorls. *Mouth* large, long, angularly pear-shaped, and oblique to the axis. *Outer lip* very thin; it is a high arched curve, straight and steep on the shoulder, and regular from the angulation downwards: the edge retreats to the left on leaving the body, and forms a wide, deep, elliptically rounded sinus occupying the whole shoulder, having above it a short triangular shelf, and below, the high elbow formed here by the prominent sweep of the lip-curve, which does not retreat till near the end of the snout. *Inner lip* is shallowly excavated in the substance of the shell, which rises beyond it with a slight edge; it is broad, and winds round the pillar; the line of it is slightly convex on the body and concave at the junction with the pillar, which is short and conical, obliquely cut off to a point, with a long, fine, rounded, and slightly twisted edge. H. 0·95. B. 0·57. Penultimate whorl, height 0·15. Mouth, height 0·62, breadth 0·35.

This is a very peculiar and beautiful species. It unites somewhat of the form of *Clavatula* with the delicate texture and sculpture of *Drillia*. The animal is so much unlike other *Pleurotomas* as to make the classification of the species very doubtful. *Thesbia*, as indicated by Dr. Gwyn Jeffreys and defined by G. O. Sars, may receive it in the meantime.

50. Pleurotoma (Thesbia) pruina, n. sp.

St. 78. July 10, 1873. Lat. 37° 26′ N., long. 25° 13′ W. San Miguel, Azores. 1000 fms. *Globigerina*-ooze.

Shell.—Strong, white, dark-brown tipped, biconical, with a short stout scalar spire, angulated whorls, a roundly contracted marginated suture, and a small body-whorl conically narrowed into a small unequal-sided snout. *Sculpture.* Longitudinals—on the earlier whorls there are very small, narrow, oblique ribs originating in a mid-whorl row of tubercles, but on the last whorl the riblets almost disappear: there are fine scratches in the lines of growth; these are peculiarly sharp and regular in the sinus-area. Spirals—the whorls are bisected by a strong angular keel, sparsely, but regularly, set with small round knobs, from which the longitudinal ribs descend; below the suture there is a narrow cylindrical collar of two fine contiguous threads: the sinus-area is free of these; but from the keel downwards the surface is covered by fine narrow rounded threads, separated by broader intervals; near the keel these are crowded; on the point they are wider apart, on the base they are most sparse: besides these, there is a delicate microscopic fretting. *Colour* porcellaneous white, dead or frosted in the interstices, but pellucid and glossy on the spiral threads; the apex is dark ruddy brown. *Spire* conical, scalar, shortish, blunt. *Apex* consists of $3\frac{1}{2}$ cylindrically globose rounded whorls separated by a linearly impressed suture; they rise to a flattened top, consisting of fully $1\frac{1}{2}$ whorls, in the midst of which lies the very minute and immersed tip. These whorls are coloured of a deep, rich, translucent, faintly ruddy brown; the earliest ones, perhaps from rubbing, are glossy, but further on they are crossed by crowded, curved, sharpish, almost microscopic riblets, between which are finely microscopic spirals whose course is not quite uniform. *Whorls* $7\frac{1}{2}$; but the shell is probably not quite full-grown; they are of very regular and slow increase, broad and short, each one laps up on the one before it, and is there shortly cylindrical, has then a pretty long, concave, and somewhat horizontal shoulder to the keel, which is right-angled; below this the whorls are cylindrical with a slight contraction downwards to the inferior suture. The body-whorl contracts from the keel downwards, with a convexly conical and very unequally-sided base, produced into a small bluntly pointed snout. *Suture* a very shallow rounded furrow defined by the infrasutural collar and the contraction of the whorls. *Mouth* angularly pear-shaped, being truncate above and prolonged into the broadish canal below. *Outer lip* leaves the body at a right angle, and advances direct to the keel, from which point to the

end of the snout it forms almost a straight line; its edge is at the keel thrown out into a high shoulder, between which and the body lies the shallow, open, rounded sinus, with a narrow triangular shelf between it and the body-whorl: the lip-edge is thin throughout. *Inner lip* is excavated somewhat deeply and flatly into the thickness of the shell, and runs on to the extreme point of the rather short and oblique pillar, whose inner edge has a long gradual twist. H. 0·37. B. 0·2. Penultimate whorl, height 0·08. Mouth, height 0·2, breadth 0·1.

The classification of this species is not very satisfactory. It may quite well be a *Surcula*; but the stained apex deserves stronger recognition than that place would give it. The sculpture of the apex is strongly suggestive of *Defrancia*; but the shape of the apex is blunter than is characteristic of that group, while the ornamentation is not really reticulate.

It has some general resemblance to *Pleurotoma torquata*, Phil.; but the sculpture is more delicate, and the spire is stumpier than in that species, which also has a sharp-pointed yellow apex with true *Defrancia*-reticulated ornamentation.

On the Nostrils of the Cormorant (*Phalacrocorax carbo*). By Professor J. C. Ewart, M.D. (Communicated by G. J. Romanes, F.R.S., Sec. L.S.)

[Read June 16, 1881.]

Having had my attention directed by Mr. Romanes to the fact that Cormorants during a long flight, and for some time after roosting, hold their heads agape as if panting, and it having been suggested by him that this fact is presumably due to a remarkable condition of the nostril which he had observed, I undertook an anatomical investigation of the latter point with the following results.

The external nostril is a mere slit situated at the end of a shallow superficial groove, which runs backwards along the beak parallel with its lower edge, and lying between its lower and middle third. When a bristle is introduced into the slit, it never

succeeds in forcing a passage into the nasal cavity. If the skin which forms the outer boundary of the slit is carefully reflexed, a groove is exposed which runs from the external slit-like nostril to a narrow canal lined apparently by modified mucous membrane. This canal, when the mucous membrane remains, is externally from $1\frac{1}{2}$ to 2 millim. in diameter; but it rapidly diminishes, and appears to end blindly. In all the specimens examined, however, when the skin has been reflexed, it is possible to pass through this canal, without forming a false passage, a bristle about the size of an ordinary horse-hair, *i. e.* less than 1 millim. in diameter. The bristle is more easily passed in young birds than in old ones: this seems to be due to the osseous canal being relatively larger than in the former. Almost immediately beyond this narrow passage is the large nasal chamber, lying above and internal to the palatine bone, and in free communication with the buccal cavity. The mucous membrane lining the nasal chamber has the same structure and the same nerve-supply as in other aquatic birds.

The nasal region of the Cormorant, and to some extent also in the Gannet (*Sula*), thus differs chiefly from the nasal arrangement in other birds:—1st, in having a very small external nostril, the passage in this slit-like aperture being almost obliterated; 2nd, in having the osseous canal only $1\frac{1}{2}$ to 2 millim. in diameter externally, and scarcely $1\frac{1}{2}$ millim. at its narrowest part; and 3rd, in having the nasal chamber in very free communication with the mouth.

This state of things, it may be presumed, explains the gaping of the bill, in the case of the Cormorant, to obtain air needful to sustain the increased activity of respiration which is produced by the exertion of prolonged flight.

Mollusca of H.M.S. 'Challenger' Expedition.—Part X.

By the Rev. Robert Boog Watson, B.A., F.R.S.E., F.L.S., &c.

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[Read June 16, 1881.]

Fam. Pleurotomidæ (*continued*).

Gen. Pleurotoma, *Lam.*

51. *Pleurotoma (Defrancia) hormophora*, n. sp.
52. *P. (D.) chariessa*, n. sp.
53. *P. (D.) pachia*, n. sp.
54. *P. (D.) pudens*, n. sp.
55. *P. (D.) araneosa*, n. sp.
56. *P. (D.) streptophora*, n. sp.
57. *P. (D.) circumvoluta*, n. sp.
58. *Pleurotoma (Defrancia) chyta*, n. sp.
59. *P. (D.) perpauxilla*, n. sp.
60. *P. (D.) perparva*, n. sp.
61. *P. (Daphnella) compsa*, n. sp.
62. *P. (D.) aulacoëssa*, n. sp.
63. *P. (Borsonia) ceroplasta*, n. sp.
64. *P. (B.) silicea*, n. sp.

51. Pleurotoma (Defrancia) hormophora, n. sp. (*ὁρμοφόρος*, collar-girt.)

St. 23. Mar. 15, 1873. Lat. 18° 24′ N., long. 63° 28′ W. Sombrero Island, St. Thomas, Danish W. Indies. 450 fms. *Globigerina*-ooze.

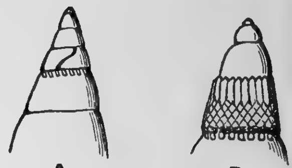
St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Dan. W. Indies. 390 fms. Coral-mud.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Pernambuco. 350 fms. Mud.

Shell.—High and narrow, with no angles anywhere; porcellaneous to ivory-white, a high conical spire, with sharp reticulately sculptured lip; the whorls are slightly convex, and have a row of beads round the top of each; the body-whorl and snout are small, and the base short and contracted. *Sculpture.* Longitudinals—none but excessively oblique, faint, hair-like lines of growth. Spirals—there is a pretty little row of rounded tubercles close to the suture at the top of the whorls—about 16 in each. The surface is also very finely and superficially microscopically scratched. *Colour* ivory-white; but when alive probably porcellaneous, glossy. *Spire* conical, with scarce any interruption in the profile-lines. *Apex* consists of 4 conical yellow whorls, rising to a minute tip; the line of junction between

these and the first regular whorl has a deep sinus above and a very prominent forward curve below. These whorls are ornamented by a system of minute bars, which for the upper half of the whorl run straight downwards (fig. 1, B); there they split into two and form a very regular reticulation on the lower half of the whorl, each mesh being a square. *Whorls* 11 in all, slightly convex, a little high, of very regular increase, each broadening downwards with great regularity, but very slightly, from the upper to the lower suture; the last whorl is a very little tumid, but short and small, and with a short contracted base. *Suture* very little impressed, but rendered definite by the very slight prominence of the edge of the gemmed band below. *Mouth* oblong, pointed above and below. *Outer lip* has a very regular and slight curve from end to end; the edge sweeps very much back at the front of the shell; in the middle of the mouth it is excessively prominent and is rounded, leaving between its shoulder and the body-whorl a very deep, rounded, and open-mouthed sinus. *Inner lip* very thinly excavated in the substance of the shell; it runs very far forward on the bluntly rounded, twisted, and at the point oblique edge of the pillar, which is short and narrow, and at its junction with the body very markedly concave. H. 0·4. B. 0·14. Penultimate whorl, height 0·08. Mouth, height 0·16, breadth 0·08.

Fig. 1.



Ornamentation on whorls, apex of *P. hormophora*.

I know nothing with which to compare this remarkable species. *Clavatula albicans*, Hinds, 'Sulphur,' p. 23. no. 84, pl. vii. f. 8, has somewhat of its general features; but there resemblance ends. *Trochus* (*Margarita*) *nitens*, Jeff., has a somewhat similarly ornamented suture; as has also *Hela margaritifera*, Wats.

52. Pleurotoma (Defrancia) chariessa, n. sp. (χαρίεις, graceful.)

St. 24. March 25, 1874. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra Island, St. Thomas, Dan. West Indies. 390 fms. Coral-mud.

St. 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W. West of Azores. 1000 fms. *Globigerina*-ooze. Bottom temperature 39°·4.

St. 78. July 10, 1873. Lat. 37° 26′ N., long. 25° 13′ W. San Miguel, Azores. 1000 fms. *Globigerina*-ooze.

St. 85. July 19, 1873. Lat. 28° 42′ N., long. 18° 6′ W. Palma, Canaries. 1125 fms. Volcanic sand.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Pernambuco. 350 fms. Mud.

Shell.—High, biconical, a little tumid, carinated, white, thin, faintly, shortly, and obliquely ribbed, with a high, subscalar, small-pointed spire, and a slightly tumid little-contracted base, produced into a long narrow snout. *Sculpture.* Longitudinals—there are on the last whorl about 20 short oblique folds, which die out almost immediately; they are highest at their origin below the sinus-area, and are parted by flat intervals somewhat broader than they; they diminish in number up the spire, and do not reach the lower suture: there are further obsolete lines of growth, which in the sinus-area are strong, and at the suture form sharp little folds parted by wide unequal intervals. Spirals—the sutural area is wide, but scarcely concave; it is bordered by the blunt angulation forming the keel, which is greatly strengthened by the prominence of the origin of the longitudinal ribs. From the keel downwards the shell is covered by superficial, flattened, irregular, and unequal threads parted by narrower shallow furrows; these become slightly stronger and more regular on the snout. *Colour* ivory-white; the apex is ruddy brown. *Spire* conical, high, rather narrow, subscalar, sometimes scalar from the squareness with which the sinus-area stands out in the upper whorls. The lines of profile are very much interrupted by the prominence of the keel. *Apex* small, ruddy brown, consisting of 4½ conical whorls; of these the lower two thirds is covered with very minute reticulations, while the upper part is scored with minute curved bars, the surface between which is very slightly spirally marked; it ends in a minute tip a little bent down on one side. *Whorls* 10 in all, of regular proportions and uniform increase; they are conical above and cylindrical below the keel; the last whorl is slightly tumid, and contracts very gradually to a long and small snout. *Suture* extremely minute as each whorl laps up on the one above it. *Mouth* oblong, pointed above, and drawn out into a long narrow canal below. *Outer lip* is pretty regularly arched from the

Fig. 2.

Reticulations on whorl of *P. chariessa.*

body to the canal, from which point it is drawn out rather straight; its edge advances in the middle very prominently; above this it forms a high shoulder, between which and the body-whorl lies the deep, rounded, and very wide-mouthed sinus; towards the front of the mouth the edge runs straight, then retreats, so as to form a broad, slight, small sinus at the top of the canal, and then runs straight. *Inner lip*: there is a thin glaze excavated slightly in the substance of the shell. The pillar is long, narrow, and fine-pointed, with a slight swelling coiling round its base, where its junction with the body is but slightly concave. H. 0·85. B. 0·35. Penultimate whorl, height 0·16. Mouth, height 0·43, breadth 0·2.

This species has a considerable likeness to *P. torquatum*, Phil.; but that is a larger, broader, stumpier form, has the individual whorls shorter, more strongly keeled, ornamented with little rounded tubercles instead of with narrow, pinched-up, very oblique riblets; has also a much more horizontal suture; the whorls, too, are not cylindrical, but contract from the keel to the lower suture; the base is much more drawn in, and the pillar much shorter; the whole texture also and sculpture is much stronger than in the 'Challenger' species.

The specimens from St. 24 and St. 85 are markedly stumpier in form, more sharply keeled, and with a higher shoulder and a rather smaller embryonic apex; but the whole details of sculpture are identical.

53. Pleurotoma (Defrancia) pachia, n. sp. (παχὺς, fat.)

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Dan. West Indies. 390 fms. Coral-mud.

Shell.—Ovate, white, smooth, of rounded outlines, with a rather high, small, and sharp-pointed apex, a swoln body-whorl, and a rounded base produced into a small, broad, one-sided snout. *Sculpture.* Longitudinals—there are only very fine hair-like lines of growth, of which here and there at regular intervals one becomes much more strongly marked than the others. Spirals—the whole surface is sparsely scored with very shallow, scratched-out, narrow furrows, parted by flat intervals of from two to six times their breadth; in the sinus-area they are a little closer than elsewhere; on the snout they gradually broaden till their

intervals assume the form of slight rounded threads. *Colour* like a shaving of ivory, from its thinness, gloss, and colour. The apex is buff. *Spire* conical. *Apex* consists of 4 very small, conical, scarcely convex, buff whorls, the upper part of which bears straight little bars, and the lower part is minutely reticulated; below the buff-coloured surface the shell is porcellaneous. *Whorls* 9 in all, slightly straight and sloping below the suture, convexly rounded above, cylindrical below; the last is a little tumid, with a rounded base produced into a short, broad, lop-sided snout. *Suture* very slight, as the inferior whorl laps up on the one above it, but it is defined by the curve of the whorls. *Mouth* oval, pointed above; there is scarcely any canal below. *Outer lip* very thin, a little contracted above, and patulous below; its curve is somewhat flattened about the periphery; its edge forms a very regular curve with a slight shoulder above, between which and the body lies the broad, shallow, rounded sinus. *Inner lip* is a thin narrow glaze which very soon dies out on the oblique, twisted, fine edge of the short conical pillar, beyond whose point the front of the shell advances a good deal: the junction of the pillar and the body is concave. H. 0·46. B. 0·22. Penultimate whorl, height 0·11. Mouth, height 0·24, breadth 0·11.

This species slightly resembles *Daphnella supercostata*, E. Sm., but is more obese, the mouth is shorter, the edge of the sinus is not thickened, and the apex is sharp and sculptured, while in that it is plain and blunt. It most resembles perhaps *Pleurotoma translucida*, Wats.; but that is smooth, and has a blunt rounded apex.

54. Pleurotoma (Defrancia) pudens, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Dan. W. Indies. 390 fms. Coral-mud.

Shell.—Small, oblong, white, smooth, with a high, subscalar, small and sharp-pointed apex, a short and scarcely swoln body-whorl, and a conical base produced into a broadish, triangular, lop-sided snout. *Sculpture.* Longitudinals—besides hair-like lines of growth, there are some faint, very oblique, upwardly convex folds, which are obsolete on the earlier and on the last whorls. Spirals—the surface is covered with superficial rounded threads

which, obsolete in the sinus-area, are feeble on the body, but sharper and more distinct on the base and snout. There is a very faint angulation below the sinus-area. *Colour*: the shell is thin, semitransparent white, with hardly any gloss. *Spire* conical, subscalar from the slight short tumidity below the suture. *Apex* consists of 4 embryonic whorls, which are buff, darkening to orange at the tip; they are a little broadly conical, rounded, with a slight angulation, and parted by a distinct suture; they rise to a very minute, spirally scratched, round, and very slightly prominent knob; they are sculptured with raised bars, which are straight and simple above, but oblique and crossed below. *Whorls* $7\frac{1}{2}$ in all; they are slightly concave and shouldered in the sinus-area, which is bordered by a faint angulation, below which they are slightly tumid, without any contraction into the inferior suture; the last, which is rather small, has a conical base produced into a broadish, triangular, one-sided snout. *Suture* slight, inasmuch as the inferior whorl laps up on the one above; but there is an appreciable constriction. *Mouth* oblong, pointed above; there is no canal below except the channel behind the pillar. *Outer lip* very thin; its curve is somewhat flattened; its edge forms a very regular sweep with a rather high shoulder above, between which and the body lies the deepish, but broad, open-mouthed sinus. *Inner lip* very thin and narrow, dying out early on the scarcely oblique or twisted edge of the longish, straight, and conical pillar, the point of which comes short of the lip-edge, and whose junction with the body is concave. H. 0·21. B. 0·1. Penultimate whorl, height 0·04. Mouth, height 0·1, breadth 0·05.

This species somewhat resembles *P.* (*D.*) *pachia*, Wats.; but is in all its proportions very much smaller; the whorls, especially the last, are very much less tumid, the spire is distinctly scalar, and the sculpture is very markedly different. Than *Daphnella attenuata*, E. Sm., besides the different apex, the whole shell is smaller, more attenuated, and more delicate.

55. PLEUROTOMA (DEFRANCIA) ARANEOSA, n. sp.

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Danish West Indies. 390 fms. Coral-mud.

Shell.—Small, yellowish, minutely ribbed and faintly spiralled, with a small, broadish, scalar, sharp-pointed spire, a slightly swoln

body-whorl and rounded base, produced into a square, prominent, one-sided snout. *Sculpture.* Longitudinals—there are exceedingly fine, faint, microscopic scratches in the line of growth; at distances of about $\frac{1}{100}$ of an inch apart these rise into small, sharpish, round-topped riblets, which run continuously from the suture to the snout, though on the base and below it they become feebler; on the earlier whorls these are of course less marked and more close set: in the intervals of the larger riblets one or two fainter ones occasionally appear. Spirals—below the slightly concave sinus-area is an obtuse angulation, accentuated by the slight prominence of the two small spiral threads which lie there; below this there are on the body-whorl above the lip-corner about 5 other small spirals not so prominent; on the lower part of the body and on the base they are weaker, but become stronger again towards the point of the base and on the snout; the intersection of these with the spirals produces a slight spider-web-like appearance*. *Colour* yellowish, without gloss; the apex is buff. *Spire* rather short and broad, scalar, and conical. *Apex* consists of $4\frac{1}{2}$ very small, conical, scalar, convex, buff whorls, parted by a deep suture; the first whorl and half is closely spirally striated with about 10 minute threads: these threads, which are at first almost simple, are by degrees more and more fretted by longitudinals, which break up the threads into minute tubercles: toward the end of the second whorl longitudinal and oblique bars appear somewhat vaguely and confusedly; but presently the distinct arrangement appears of short little bars above and a network on the lower part of the whorls. *Whorls* $7\frac{1}{2}$ in all, but the shell is very likely hardly full-grown: they are almost horizontal above, with a flat or faintly concave sinus-area, slightly angulated at the shoulder, and below this cylindrical or a very little convex to the lower suture; the last is rather short, a little tumid, with a long pillar-line on the left side, and a small square prominent snout on the right. *Suture* very slight in consequence of the uplap of the whorls at their junction, but of course strongly marked by the angulation of the line of junction. *Mouth* oblong, triangularly pointed above, and ending in a very square broadish canal below. *Outer lip* flatly arched, with a slight angulation below the sinus-area and a marked pinch-in where it turns to form

* From this the name is derived.

the canal; its edge-line is very straight and scarcely prominent, but has a high shoulder above, between which and the body lies the deepish, rounded, and open-mouthed sinus. *Inner lip* very thin and narrow, and dying out very early on the scarcely oblique, twisted, sharp pillar-edge; its line across the body is very short and convex, but is very concave at its junction with the long, scarcely oblique pillar. H. 0·22. B. 0·1. Penultimate whorl, height 0·04. Mouth, height 0·13, breadth 0·04.

This is like *P.* (*D.*) *pudens*, but differs markedly in its more angular outlines and square pinched-out snout.

56. Pleurotoma (Defrancia) streptophora, n. sp. (*στρεπτοφόρος*, necklace-wearing.)

North Atlantic. April or May 1873. (Station not entered.) Over 1000 fms.

Shell.—White, strong, porcellaneous, stumpy, with a very short body-whorl, a double necklace of tubercles below the suture, a rather high, small-tipped, buff-pointed spire, a rounded base, small, broadish, reverted snout, and a twisted pillar. *Sculpture.* Longitudinals—there are about 12 narrow ridge-shaped ribs on each whorl: they originate below the sinus-area in conical-shaped little tubercles, and die out at the point of the base; they are parted by shallow rounded furrows of about three times their breadth. The lines of growth, which are pretty strong, cover the whole surface. Spirals—close below the suture is a row of small, rather coarse, and not quite regular-rounded tubercles, about 24–26 in number: these form an angulated ring as a subsutural margination; adjacent to them is the row of more prominent costal conical-shaped tubercles. The body of the whorl below these is feebly striate. Toward the end of the base is a sharpish furrow succeeded by a broadish flat band, below which on the extreme point of the base is a series of 4 sharp narrow threads and furrows, followed by about as many more, smaller and more crowded on the snout. *Colour* porcellaneous white, glossy, with a buff tip. *Spire* long relatively to the shell, shortly scalar, convexly conical. *Apex*: the extreme tip is broken, but had evidently been very small; two whorls remain, rounded, high, conical, parted by a distinct suture, buff-coloured, minutely straight-barred above and reticulated below, as in the type.

Whorls 5, below the embryonic apex; probably about 9 in all. The rows of infrasutural tubercles give them a minute double keel above with an oblique slope at this part, below which they are cylindrical, or very slightly contracted to the lower whorl: this contraction is distinct on the last whorl, which is very small. The base is rounded and contracted, and ends bluntly in a triangular snout with a slightly reverted point; the advance of the pillar on the left side is rather more than one would have expected. *Suture* small, but very strongly marked. *Mouth* ovate, contracted and angulated above, produced into the broad, open, and oblique canal below. *Outer lip* confused by having been broken and mended; but apparently thickened and probably marginated above, very flatly curved with great regularity from end to end; the edge runs very straight with little of prominence, and forms a very slight and shallow rounded sinus near, but not quite close to, the suture, from which it seems to be separated by an extension of the upper beaded line. *Inner lip* broad, formed by a glossy pad above, and below it is slightly excavated into the substance of the shell. It runs straight out along the pillar to the very point, where it meets the very oblique, twisted, and thickened edge: the pillar is thus very short, stumpy, and obliquely cut off in front, reminding one of a *Nassa*; and its whole point is a little twisted and reverted. H. 0·31. B. 0·13. Penultimate whorl, height 0·06. Mouth, height 0·13, breadth 0·07.

57. Pleurotoma (Defrancia) circumvoluta, n. sp.

St. 23. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. North of Culebra Island, St. Thomas, Danish West Indies. 390 fms. Coral-mud.

Shell.—White, strong, with a high, scalar, small, buff-tipped spire, an excessively small body, and a contracted conical base. *Sculpture.* Longitudinals—there are on each whorl about 14 slight, narrow, ridge-shaped, round-topped, oblique and slightly irregular riblets; they rise sharply in obscure tubercles below the sinus-area, and die out at the point of the base; they are parted by shallow rounded furrows of more than twice their breadth. The sinus-area is scored by minute cusp-like remote bars, which generally are not continuous, but are interrupted about the middle, and are more numerous on the lower than the upper half of the area: the lines of growth are extremely fine. Spirals—

the sinus-area is occupied by a broadish, square, impressed furrow; below this there is a square-edged shoulder caused by the projection of the ribs at their origin; this forms a blunt but strongish keel. The rest of the whorl is covered by about 12 fine rounded threads (exclusive of those belonging to the snout, which is broken); the two threads at the keel are close-set; the others are pretty equal and equally arranged; on the penultimate whorl there are about 8 of these threads. *Colour* dead white, probably porcellaneous when fresh; the apex is buff or sandy-coloured. *Spire* high, scalar, conical. *Apex* small, high, conical, with the typical straight bars above, and obliquely reticulated ones below; the two or three of the very tip are broken. *Whorls* 6 below the apex; they are short and broad, of slow regular increase, with a drooping slightly concave shoulder, keeled, and from the keel contracting conically to the inferior suture; the last whorl is very short and small, with a rounded convexly conical base: the extreme point of the pillar and snout is broken. *Suture* obtusely, but angularly, impressed. *Mouth* oval. *Outer lip* almost semicircular, with an angle at the keel; its edge advances very far forward below; above it forms a very deep, wide, funnel-shaped sinus close up to the suture. *Inner lip* slightly excavated, with a very small border. H. 0·36. B. 0·13. Penultimate whorl, height 0·06. Mouth, height 0·1, breadth 0·08. (These measurements are of necessity, from the broken state of the mouth, somewhat hypothetical; but they are at least not exaggerated.)

58. Pleurotoma (Defrancia) chyta, n. sp. (χυτὸς, cast.)

St. 73. June 30, 1873. Lat. 38° 30′ N., long. 31° 14′ W. West of Azores. 1000 fms. *Globigerina*-ooze. Bottom temperature 39°·4.

Shell.—White, conical, ribbed, with a high, subscalar, small-pointed apex, a short tumid body-whorl, a rounded contracted base, and a small snout. *Sculpture.* Longitudinals—there are on the last whorl 14 ridge-shaped, round-topped, curved, oblique ribs: they are not strong, originate in small rounded beads at an angulation below the sinus-area, and die out on the base: they are parted by shallow rounded furrows of double their breadth; on the first regular whorl they appear as simple beads 9 in number; on the next whorl they assume the form of straight

riblets, whose obliquity increases on each successive whorl: the lines of growth, which are quite independent of the riblets, are very slight. Spirals—there is a row of quite separate, very small, elongated tubercles below the suture: the sinus-area is bordered on its lower side by a very faint and small furrow: the angulation of the whorl below this is chiefly due to the row of beads in which the ribs originate, and here there are several very minute threads: 9 somewhat stronger, equal, and equally parted threads occupy the body from this angle downwards; about 5 others, stronger and wider apart, occupy the base, and about 4 more the snout; here and there a much finer thread occurs in the intervals. *Colour* white. *Spire* high, subscalar, conical. *Apex* small, high, conical, with tumid whorls; the sculpture is typical, *i. e.* with straight bars above and obliquely reticulated ones below; the two or three of the very tip are broken. *Whorls* 6–7, exclusive of those which form the apex, of regular increase, with a drooping concave shoulder, keeled, and below the keel almost cylindrical, but with a very slight contraction to the lower suture; the last whorl is short, tumid, with a rounded base produced into a short, broad, triangular, one-sided snout. *Suture* very slightly impressed and extremely small, as the inferior whorl laps up on the one above it. *Mouth* angularly oval, pointed above, broad in the middle, and obliquely prolonged below into the short canal. *Outer lip* concave in the sinus-area and angulated at the keel; it forms from this point a very regular curve to the front: the edge, which sweeps far out below, forms rather a low shoulder above, between which and the body lies the deep, rather narrow, open-mouthed, rounded sinus. *Inner lip* is excavated, has a slight raised border outside of it, is rather broad, and continues to the extreme point of the short narrowish pillar, which is rather obliquely cut off with a rounded twisted edge, and whose junction with the body is deeply concave. H. 0·54. B. 0·24. Penultimate whorl, height 0·1. Mouth, height 0·24, breadth 0·13.

This species has some resemblance to one which Dr. Gwyn Jeffreys got in the 'Porcupine' dredgings from 994 fathoms, and in the 'Travailleur' dredgings in the Bay of Biscay, and which he proposes to call *Defrancia formosa*—a name with this disadvantage, that there is already a *Pleurotoma formosa* of Reeve. In the 'Challenger' expedition it was got at St. 24, St. 73, St. 78,

and St. 85; but all the specimens are very young. From its reticulated sculpture I had called it *P.* (*Defrancia*) *cribraria.* There is another 'Challenger' species it resembles from St. 73, and for which I had chosen the name *P.* (*D.*) *smileuta*, unfortunately also a young specimen. The distinction between the present species and these others is expressed by the name *chyta* (χυτὸς, cast); while *P.* (*D.*) *smileuta* (σμιλευτὸς, chipped out) is like a thing blocked out of the solid. *P.* (*D.*) *formosa*, Jeff., again resembles something on which superficial ornament has been laid and attached by melting. In all three cases there is a resemblance in the forms and sculpture; but under that resemblance there is the strongest difference.

59. Pleurotoma (Defrancia) perpauxilla, n. sp.

St. 24. March 25, 1873. Lat. 18° 30′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—Very small, high and narrow, white, ribbed and spiralled, with convex whorls, a small elongated regular body, impressed suture, a high, conical, small-tipped spire, a rounded base, and a small, longish, triangular, one-sided snout. *Sculpture.* Longitudinals—there are on the latter whorls about 9 biggish flatly rounded ribs, parted by equally broad open rounded furrows; in the upper whorls they barely reach the lower suture; on the last they hardly extend to the base; they originate at a shoulder below the sinus-area; they are thus very short. The lines of growth are very faint, except in the sinus-area, where, round the top of the whorls, the old sinus-scars form a series of short, sharp, regular, remote, little riblets. Spirals—below the sinus-area is a feeble thread; the periphery of the whorls is marked by two sharp, square-topped threads, which form a double keel; the upper one is very near the feeble thread above mentioned: the interval between the carinal threads is about four times their breadth; somewhat more remote, a third thread, equally strong, appears on the last whorl, coming out exactly from the oral angle and defining the base; above and below this, at about equal distances, are two feebler threads; the rest of the base is bare, but the entire snout is covered with very small spiral threads. The entire surface is very minutely scored with microscopic spiral lines. *Colour* frosted white, with a buff apex. *Apex*: there are

four embryonic whorls, which form a high cone with a slightly impressed suture, and rise to a small rounded prominent tip: the sculpture is typical, the tip being scored with some 10 or 12 minute sharp spiral threads, while the other whorls have straight bars on the upper part and reticulated bars below, only the part occupied by the straight bars is exceptionally short. *Whorls* 7–8, of regular increase, with a drooping shoulder, a double carination, and a marked contraction to the inferior suture; the last whorl is very regular in form, with a slightly contracted base, from which projects a small triangular one-sided snout. *Suture* slightly impressed, flatly but minutely marginated below. *Mouth* oval, angulated above, and prolonged into a rather broad and longish canal below. *Outer lip* very regularly curved, but drawn out straight along the canal: its edge, which is rather prominently curved below, forms a somewhat low shoulder above, between which and the body lies the wide-mouthed, deep, rounded sinus. *Inner lip* rather broad and distinct; it is very early cut off on the short pillar at the very oblique twisted edge, which then runs on as a thin sharp margin to the canal: the junction of the pillar and body is rather deeply concave. H. 0·15. B. 0·6. Penultimate whorl, height 0·026. Mouth, height 0·06, breadth 0·03.

This is a very small species; but I think one of the specimens is very nearly full-grown.

60. Pleurotoma (Defrancia ?) perparva, n. sp.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Pernambuco. 350 fms. Mud.

Shell.—Small, high and narrow, ribbed and spiralled, with convex whorls, a small short body, impressed suture, a high, conical, scalar, small-tipped spire, a rounded base, and a small, short, triangular, one-sided snout. *Sculpture.* Longitudinals—there are on the last whorl 12, on the earlier one or two fewer, small, straight, rounded ribs, which originate somewhat prominently in an angle of the whorls below the sinus-area, and run down to the point of the base, but do not extend to the snout; they are parted by rounded furrows of nearly three times their width: close below the sinus is a crowded row of very short, small, curved bars—the old sinus-scars. The whole surface is closely, very regularly, and rather sharply scored with lines of

growth. Spirals—the earlier whorls are keeled by three equal, equally prominent, and equally parted rounded threads; on the last whorl others, weaker, appear between these; the lowest of the three loses in importance, and about seven others, not all quite equal nor quite equally parted, occupy the base, while four or five more somewhat similar cover the snout. *Colour* probably white, but stained with mud in which the specimens have lain. *Apex*: there are 4 embryonic whorls, which form a high cone with a slightly impressed suture; the extreme tip has evidently been small, but is broken: the sculpture is not typical, but consists of a series of straight bars ornamented with rough and projecting tubercles; these cross the whorls, but at the top and bottom of the whorls another set of short little bars occur between the larger ones. *Whorls*: these are 9 in all, of regular increase, rather short; above they are slightly concavely horizontal, at the three keels cylindrical, and below this contracted into the inferior suture; the last whorl is very short, a very little swoln, with a very short rounded base and a small snout. *Suture* impressed, but open. *Mouth* small, oval, rounded above, and drawn out into a canal below. *Outer lip* straight in the sinus-area, high-arched in the middle, concave in front, and straight along the canal: the edge forms a high shoulder above, between which and the body is the open, deep, rounded sinus. *Inner lip* thinly excavated, very early cut off at the sharp oblique edge of the pillar. H. 0·23. B. 0·09. Penultimate whorl, height 0·045. Mouth, height 0·09, breadth 0·05.

This species is classed under *Defrancia* only provisionally with a mark of interrogation, in consequence of the departure of the embryonic whorls from the typical sculpture. That sculpture and form of apex may probably serve as the safest basis of classification in the whole group.

61. Pleurotoma (Daphnella) compsa, n. sp. (κομψὸς, neat.)

St. 174D. August 3, 1874. Lat. 19° 5′ 50″ S., long. 178° 16′ 20″ E. Kandavu, Fiji. 210 fms. *Globigerina*-ooze.

Shell.—High, narrow, fusiform, white, with pale irregular ruddy-brown spots near the suture and at the apex, which is small and sharp; the whorls are rounded and reticulately ribbed, the last narrow and drawn out on the base; it has a high subscalar spire; the mouth is long and rather narrow, the outer lip thickened within and without, with a small sinus above and a

distinct canal in front. *Sculpture.* Longitudinals—on the earlier whorls there are sharp, narrow, prominent, slightly oblique, remote ribs; these increase in number and diminish in distinctness, till on the last whorl they are very numerous, crowded, and insignificant: this arises from intermediate riblets, which are almost invisible on the earlier whorls, reaching on the last a prominence equal to that of the others; these are best seen in the sinus-area. Behind the lip is a strong and broad varix, scored with the riblets, and bevelled off to a thin prominent edge. Spirals—the whole surface is covered with fine sharp raised spirals, very often alternating with finer ones in the intervals; they are separated by shallow square furrows of about the same breadth as the spirals; at their intersections with the longitudinals they are slightly nodose: in the sinus-area there are only fine crowded spirals, whilst on the snout these are strong and remote. *Colour* dead porcellaneous white, with a few faint ruddy-brown blotches near the top of the whorls and toward the outer lip. *Spire* high, conical, scalar. *Apex* small, sharp, conical, consisting of 3–4 ruddy rounded embryonic whorls, the sculpture of which is that of the typical *Defrancia* group, *i. e.* the upper half of the whorls is scored longitudinally by very numerous minute, sharp, raised, curved bars, which split into two and cover the lower half of the whorls with exquisite little square-shaped reticulations formed by the crossing of the bars. *Whorls* 9–10 in all, of regular, but rather rapid increase: they are at first rather broad, but the penultimate is high and the last rather long and narrow; they rise in steps one above another, being a little flattened above, are well rounded, and have a slight contraction into the lower suture; the last is produced into a very lop-sided, long, and somewhat oblique and obliquely truncated snout. *Suture* is strongly marked by the slight contraction of the whorl above, and a constriction of the shoulder of the whorl below, but is not really deep, for the inferior whorl laps up on that above it. *Mouth* long, narrow, oblong, sharply pointed above, and produced into an open broadish spout-like canal below. *Outer lip* forms a regular flat curve to the canal, where it is slightly concave and then straight; at its junction with the body there is a strongly marked little rounded nick which cuts into the edge, but is bordered by a small encircling pad lying between it and the body-whorl; this nick is the generic sinus, and the scars of it are marked on all the whorls; the extreme edge of the lip is thin and sharp, but there is a

strongish white porcellaneous pad a little way within; this pad does not extend to the canal, the edge of which at the point is very obliquely cut off from right to left. *Inner lip*, as mentioned there is a small pad above formed by an extension of the outer lip: this is continued across the body as a porcellaneous layer, thinning out and disappearing on the pillar, which is cut off in front with a long obliquity, whose edge is rounded, but hardly twisted. H. 0·8. B. 0·27. Penultimate whorl, height 0·14. Mouth, height 0·42, breadth 0·13.

This is a very beautiful species in form and in sculpture. It may perhaps best be compared with *P. hyalina*, Reeve, or with *Mangelia cylindrica*, Reeve, or *M. gracilis*, Reeve, or *M. fragilis*, Reeve, but is not very much like any of them. Its apex distinctly connects it with the *Defrancia* group of which *Daphnella** (f. auctorum *nec* Hinds) is a subdivision; and I have accordingly placed it here, though aware that it is not very like some of the species which have been thus named.

62. Pleurotoma (Daphnella) aulacoëssa, n. sp. (αὐλακόεις, furrowed.)

St. 188. September 10, 1874. Lat. 9° 59′ S., long. 139° 42′ E. W. of Cape York, off the S.W. point of Papua. 28 fms. Mud.

Shell.—High, narrow, fusiform, white; the whorls are convexly cylindrical; the spire high, narrow, subscalar, and conical; the body-whorl is long, narrow, and conical, with a small snout; the lip has a thin crimped edge; the sinus is small, but very well defined at the extreme top of the long narrow mouth. *Sculpture*. Longitudinals—there are on each whorl many (27 on penultimate, about 40 on the last whorl) fine, rounded, curved threads, which correspond with the old lines of growth; they are parted by minute furrows, which are rather narrower than the threads. These longitudinals extend to the base, but not to the snout. Spirals—the riblets are crossed by very similar spiral threads which form minute knots at the crossings, and these are parted by little furrows which are rather wider and less regular than the longitudinal ones, and have occasionally subsidiary threadlets in the middle: there are about 7 of these spirals on the penultimate and about 14 on the last whorl: the sinus-area has very faint

* Hinds, who is the author of this genus (see Zool. 'Sulphur,' p. 25), puts it after *Conopleura* and before *Mangelia*, but gives no further indication of its family relations. Its connexion with *Defrancia* is therefore with me more a hope than a conviction.

threadlets, about three in number, and the first regular spiral below these is stronger than all the rest, and forms a slight keel; they cover the whole snout. *Colour* white. *Spire* high, conical, subscalar. *Apex* small, sharp, consisting of three (probably, for the extreme tip is broken) embryonic whorls which have the typical *Defrancia*-sculpture, the upper third being straight barred and the lower two thirds reticulately barred; but the sculpture is very fine. *Whorls* about 8 in all, of regular but rapid increase; in form convexly conical, slightly shouldered above: the last, which is narrow, is produced into a convexly conical base and a short oblique-ended snout. *Suture* is slightly impressed, and is somewhat strongly marked by the swelling of the whorl immediately below. *Mouth* narrowly oblong, bluntly pointed above, where it runs out into the small but rather deeply impressed and rounded gutter of the sinus, and produced below into a broadish canal. *Outer lip* regularly curved, but at the canal flattened; the edge forms a regularly curved sweep, prominent in the middle, and retreating into the sinus and canal; it is slightly contracted, sharp, crimped rather than toothed, thickened a little way within; in the sinus it is blunted and rounded into a gutter: an extension of the outer lip surrounds the sinus and forms a small pad between that and the body-whorl. *Inner lip*: there is a very thin glaze on the body and pillar: the edge of the pillar in front has a very slight oblique bend, and is sharply rounded, but scarce twisted. H. 0·31. B. 0·12. Penultimate whorl, height 0·07. Mouth, height 0·15, breadth 0·05.

This markedly belongs to the same group as the preceding. It has the same *Defrancia* apex and much the same form as that, and is therefore comparable with the species there referred to; but it is obviously very distinct from them all.

63. PLEUROTOMA (BORSONIA) CEROPLASTA, n. sp. (*κηρόπλαστος*, waxen.)

St. 24. March 25, 1873. Lat. 18° 38′ 30″ N., long. 65° 5′ 30″ W. N. of Culebra Island, St. Thomas, Danish W. Indies. 390 fms. Coral-mud.

Shell.—High, narrow, biconical, with a tall blunt spire, a slightly impressed suture, and a shortish base: the whorls are feebly ribbed and very obsoletely spiralled. *Sculpture*: there are on the earlier whorls about 12, on the last two whorls about 14 elongated tubercles, which project bluntly and slightly above

the middle of the whorls, and are obliquely and feebly produced to the inferior suture; they are obsolete on the base: the surface is closely scratched with fine, somewhat unequal lines of growth. Spirals—there is a very slight pad which forms an inferior margin to the suture; below this is a hardly concave furrow, on the lower side of which the whorls are angulated by the projection of the tubercles: the lower part of the whorls is very obsoletely marked with broad flat spiral threads, which may be traced to the tip of the snout. *Colour* pale waxy white, whence the name. *Spire* conical, with profile-lines interrupted by the prominence of the keel, from which both above and below is a contraction into the suture. *Apex* consists of 2 tumid rounded whorls of nearly equal size, with a very slight suture. *Whorls* 8 in all, of slow and regular increase; the last is small, with a rounded conical base and a smallish snout: they are angularly convex, with a slight contraction into the suture, both at top and bottom of the whorls. *Suture* a little impressed, rather oblique. *Mouth* small and narrow, pear-shaped, scarcely angulated above, and drawn out into a rather narrow canal in front. *Outer lip* regularly curved above, flat in front: the edge retires slightly below the suture, so as to form the deep rather narrow sinus, whose lower side is made by the very high and prominent shoulder, which advances very far forward, and still continues to do so though more slightly on to the edge of the canal, where it again retires to the left. *Inner lip*: there is a thin glaze on the body and pillar whose union is very slightly concave: the generic fold is a prominent, rounded, narrow thread which coils round the pillar about the middle and parallel to the suture: the front of the pillar is narrow, twisted, and oblique. H. 0·5. B. 0·2. Penultimate whorl, height 0·08. Mouth, height 0·23, breadth 0·09.

It is interesting to add a new species, and that from the Atlantic, to the few living Pacific species of this Tertiary fossil genus. The whole aspect of the shell is that of a *Pleurotoma* of the *Surcula* group.

64. PLEUROTOMA (BORSONIA) SILICEA, n. sp.

St. 122. September 10, 1873. Lat. 9° 5′ S., long. 34° 50′ W. Off Pernambuco. 350 fms. Mud.

Shell.—High, narrow, biconical, with a tall, blunt, scalar spire, and a short contracted base: whorls angulated, but hardly prominent above, tubercled but scarcely ribbed, obsoletely spiralled. *Sculpture*: there are in the middle of the whorls small

rounded tubercles, of which there are about 11 on the first ordinary and 16 on the last whorl; on the earlier whorls they are feebly prolonged downwards as riblets, but become weaker on the last whorls. The whole surface is closely scratched with hair-like and somewhat irregular lines of growth. Spirals—an exceedingly slight pad forms a faint inferior margination to the suture: between this and the line of tubercles the profile is oblique and straight, not concave: below the keel formed by the tubercles are a few very faint and sparse spiral threads. *Colour* pale flinty, whence the name. *Spire* conical, with interrupted profile-lines. *Apex* consists of two glossy, tumid, rounded whorls of nearly equal size, and with a very slight suture. *Whorls* 8 in all, of slow and regular increase; they are shouldered above and almost cylindrical below the keel; the last is small, contracts from the keel, and has a short, conical, hardly tumid base prolonged into a short small snout. *Suture* very slightly impressed, rather oblique. *Mouth* small, narrow, pear-shaped, angulated above, and drawn out into a short open canal in front. *Outer lip* steeply curved above, a little flatly prolonged forward; its edge, which retreats at the canal, is prominently rounded in the middle, and forms a high shoulder above, between which and the body is the rather deep, narrow, rounded sinus. *Inner lip*: there is a thinnish glaze on the body and pillar, whose union is very slightly concave; at that point occurs the generic fold, which is somewhat remote within the mouth, and is a rather strong thread; the front of the pillar is rather oblique, sharpish, and twisted. H. 0·41. B. 0·15. Penultimate whorl, height 0·06. Mouth, height 0·09, breadth 0·07.

This species differs from the preceding (which it very much resembles) in that the shell is smaller, the whorls more sharply keeled (the carination, too, higher), the contraction of their lower part less marked, the tubercles are rounder and tend less to be drawn out into riblets, the form of the shell is narrower, and the apex is much smaller.

On the Genus *Plocamia*, Schmidt, and on some other Sponges of the Order Echinonemata. By Stuart O. Ridley, M.A., F.L.S. With Descriptions of two additional new Species of *Dirrhopalum* by Prof. P. Martin Duncan, M.B. Lond., F.R.S., F.L.S., &c.

[Read June 2, 1881.]

(Plates XXVIII. & XXIX.)

Part I.

Introductory Remarks, and Descriptions of Species of Dirrhopalum. By S. O. Ridley.

Although the genus *Plocamia* was only recognized as a distinct type in the year 1870*, it now proves to be one of the most widely distributed, as well as one of the most beautiful, of the now numerous genera of the interesting order to which it belongs. Hitherto only three species have been assigned to it, viz.:—

Plocamia gymnazusa, Schmidt, Spong. atl. Geb. p. 62, pl. iv. fig. 18. Cuba, 270 fathoms.

P. clopetaria, Schmidt, *l. c.* p. 63, pl. iv. fig. 17. Florida, 195 fathoms.

P. plena, Sollas, Ann. & Mag. N. H. (5) iv. p. 44, pl. vi. W. Africa, Lat. 15° S. Depth?

In the present paper I have described† a new species from New Zealand, and given annotations on others previously described under other generic names; the latter are known, one from Ireland, another from Ceylon, and another from Cape St. Vincent.

No species has been described from the Arctic regions; but Ehrenberg (Zweite deutsche Nordpolarfahrt, pl. iv. fig. 8) figures from the sea in the neighbourhood of either Spitzbergen or East Greenland a cylindrical spicule, entirely spined, arcuately curved, slightly enlarged at the ends, which probably belongs to an unknown species allied to *Dirrhopalum* (*Hymeraphia*) *microcionides*, Carter. Ehrenberg names the spicule *Amphidiscus anceps*.

The distribution of the genus is thus now seen to extend from the Equatorial Atlantic to the South Pacific Ocean, and into the Indian Ocean and North Atlantic.

* O. Schmidt, Spong. atl. Geb. p. 62.

† *Note.*—The terminology here adopted is, in general, that of Mr. Carter (Ann. & Mag. N. H. (4) xvi. p. 1 &c.). Measurements of spicules are the *average maximum* measurements; the *diameters* given are the *greatest* diameters of the spicules.

The name, under the form *Plocamium*, was long ago applied to a genus of seaweeds by J. P. Lamouroux ('Résumé de Phytographie,' vol. i. 1828, p. 38), and adopted by Kützing and subsequent writers. This genus has therefore precedence of *Plocamia*; and as a change is obviously necessary, I shall adopt throughout the rest of this paper the name *Dirrhopalum**, which Prof. P. M. Duncan has suggested for the genus distinguished by Schmidt.

Two definitions have been given of the genus, the one by Schmidt (*l. c. suprà*), the other (ostensibly a definition of the new group to which he assigns it, but practically, as being the only genus included, a generic diagnosis) by Sollas (Ann. & Mag. Nat. Hist. (5) iv. p. 47). Both need modification in the present state of our knowledge. Thus Schmidt, assuming, on insufficient grounds, that the second of his two species would prove to be upright and branched in the adult state, attributed this character to the genus, "Schwämme mit incrustirender Basis und darauf sich erhebendem ästigem Geflecht," which must give way, considering that no branching specimens of the species in question have yet been described. Sollas's definition includes the same hitherto unjustified character. An examination or study of the descriptions of the different species now assigned to the genus shows that the diagnosis should stand at present:—

"Echinonematous Sponges. Growth incrusting or upright: in the former case formed by a basal lamina of a dumbbell-shaped spicule characteristic of the genus, from which spring tufts of acuate or slightly spinulate spicules radiating from axes formed by larger smooth acuates or subspinulates, which are enclosed by ceratinous or pseudo-ceratinous fibre; when the growth is upright, the spicular tufts are set in whorls on fibres which are at right angles to the axis of the stem, branch, or frond, and which are similarly connected by horizontal fibres containing the dumbbell spicule. Flesh-spicules, if present, a tricurvate (German 'Bogen') or equianchorate ('Haken'), or both."

With regard to the distinctness of the dumbbell form of spicule, which has justly been made a prominent character of the genus, it must be remembered that it differs but little in the principles of its construction from another type (the "*tibiella*" of Carter, "cylindrical" or "subfusiformi-cylindrical" of Bowerbank) occurring in several well-known sponges, as in the genus

* δὶς twice, and ῥόπαλον a club, alluding to the doubly clavate or dumbbell-shaped spicule.

Alebion, Gray (=*Halichondria Pattersoni*, *nigricans*, *pulchella*, Bowerbank, &c.), and *Tedania*, Gray (*T. nigrescens*, *Muggiana*, *digitata*, Schmidt, &c.), *Cribrella hospitalis*, Schmidt, and foreshadowed in the long cylindricals of *Suberotelites mercator*, Sdt., and *Desmacidon columella*, Bowerbank, in which a magnifying-power of about 400 diameters reveals a slight inflation. The "tibiella" also occurs in *Hymeniacidon armatura*, Bowerbank, *Suberites fuliginosus* and in *Halichondria infrequens*, Carter, and *Desmacidon dianæ*, *emphysema*, *physa*, *anceps*, Schmidt. As to its relations to other linear spicules, see p. 485, where the systematic position of the genus is discussed.

The dumbbell spicule may, however, be distinguished from the "tibiella" by its having the maximum length not exceeding 20 of its own maximum diameters, and by its being always arcuately curved.

I propose to give notes on the species to be assigned to the genus, adding, in the case of those which are now assigned to it for the first time, the reasons which have led me to adopt this course in their respective cases. Beginning with Schmidt's own species, those on which the genus was based, I find it necessary to supplement his short descriptions by fuller details, taken from the microscopic preparations supplied by himself to the British Museum. It will be seen that the result of an examination of these preparations justifies, in part, Sollas's supposition (Ann. & Mag. N. H. (5) iv. p. 46) that Schmidt had perhaps overlooked the flesh-spicules of his species.

1. Dirrhopalum gymnazon. (Plate XXIX. figs. 1, 2.)

Plocamia gymnazusa, *Schmidt*, *Spong. atl. Geb.* p. 62, pl. iv. fig. 17.

To the details given by Schmidt (*l. c.*) should be added the following:—

Bases of echinating- and main-fibre spicules connected by yellow ceratinous (?) * material. No spinulate spicules as stated by Schmidt.

Skeleton-spicules of three kinds:—(1) Long, slender, smooth, slightly curved acuate, tapering from the base to the sharp point; size 2·13 to 2·48 by ·04434 millim. (2) Stout smooth acuate, tapering to a sharp point from within quarter of its length from the base, and slightly tapering to the base from the same

* As the slide appears to have a talc cover, the test of polarization (see p. 481 ad init. and note) is inapplicable here.

point; bent, but not so sharply as in Schmidt's figure 17*b*; size 0·99 by ·06334 millim. (3) Dumbbell or double-headed, curved, cylindrical spicule; size ·479 by ·06334 millim.

Flesh-spicules of two kinds:—(1) Tricurvate acerate, bow-shaped, tapering gradually from centre to sharp points; size ·082 by ·003167 millim. (2) Equianchorate, bipalmate, the palms with squarely truncate proximal margins, shaft almost straight; length about ·019 millim.

2. Dirrhopalum? clopetarium.

Plocamia clopetaria, *Schmidt, l. c.* p. 63, pl. iv. fig. 18.

Consisting of a basal lamina, in which the dumbbell spicules and a peculiar pegtop-like form (4) are united by ceratinous material (polarizing light) and sarcode, and of spicular tufts rising from this lamina, and consisting each of a very large basally-spined acuate (1) surrounded by a considerable number of small spicules (2) of a similar kind; the bases of the spicules in the tuft are united by ceratinous material.

It is possible that the points of the peculiar form (4) feebly echinate the basal lamina. In any case they cannot be varieties of the dumbbell spicule, as stated by Schmidt (*l. c.*), for no transition forms occur in the same preparation, and their independent existence in the fossil state is undoubted (see p. 486).

Skeleton-spicules of four forms:—(1) Large, curved acuate, the base finely tuberculate; length (none were found entire) probably about 1·8 millim., thickness ·057 millim. (2) Small, straight acuate, basally spined, slightly constricted just above base; size ·29 by ·01108 millim. (3) Dumbbell spicule, curved so as to form about a third part of a circle, coarsely tuberculate in approximately verticillate whorls on shaft, evenly so over the ends; both ends and centre of shaft inflated to the same diameter; size ·152 millim. long, inflated ends and centre ·05067 millim. thick. (4) Short, rapidly tapering acuate ("pegtop"-shaped spicule), coarsely tuberculate; one sixth of the apical end is almost smooth, becomes more rapidly narrow than the rest, and is traversed to its extremity by the central canal; size ·1647 by ·076 millim.

Flesh-spicules.—None were found after careful search in the mounting (which, however, is small) in the Museum collection, unless tricurvates are represented by a single specimen of a fine barely tricurvate acerate; size ·108 by ·003167 millim.

Obs. If the flesh-spicules should really be wanting, this species

should perhaps, looking to the peculiarity and antiquity of its characteristic spicule (4), be made the type of a distinct genus. I shall, for the present, allude to forms which resemble it as belonging to the "*clopetarium* section" of the genus *Dirrhopalum*.

3. Dirrhopalum plenum.

Plocamia plena, *Sollas, Ann. & Mag. N. H.* (5) iv. p. 44, pls. vi. & vii.

A member of the typical section of the genus, *i. e.* of that part which is represented by *D. gymnazon*, for it has a smooth-shafted dumbbell spicule coexisting with equianchorate and tricurvate flesh-spicules. The short-spined acuate (plate vi. fig. 5, &c.), with the coarse and backwardly-directed spines of its shaft and the somewhat tubercular spines of its base, may perhaps represent the pegtop-like form of *D. clopetarium*, and thus the species may form one link in the chain, if it ever existed, between that species and *D. gymnazon*. This may well be, for if *D. clopetarium* is ultimately found, like *D. gymnazon*, to have the flesh-spicules, the only important points then separating it from *D. plenum* would be the tuberculation of the shaft of the dumbbell spicule, the tuberculate character of the short-spined acerate, and possibly (and, if so, most important of all) the non-echinating position of this spicule, which is distinctly an echinating form in *D. plenum*.

The arrangement of the skeleton of *D. plenum* is also typically Dirrhopaline, showing a vertical or primary fibre echinated by an acuate and subspinulate spicule, and a horizontal or secondary fibre or tract containing the dumbbell form. The yellow colour ascribed to the sarcode, and the firm consistency of the skeleton, appear to me to indicate that there is a decided admixture of a ceratinous element, or of some analogous substance, in it, in spite of Mr. Sollas's conclusions derived from facts of some importance. Whatever, however, may be the case with this species, it certainly seems to occur in an undoubted *Dirrhopalum*, viz. *D. manaarense*, Carter, which I have examined, where its prominence is the most striking point about the fibre of the stem, when freshly mounted in balsam or when treated with strong alcohol. I am inclined to think that some forms of ceratinous material have a refractive index so near that of Canada balsam as to be hardly distinguishable when mounted in that medium. In opposition to this view, however, Sollas's experiments with glycerine jelly still remain. The firmness of union of the various spicules in this Echinonematous genus seems to demand some

more powerful uniting agent than mere sarcode: such a material is sometimes to be distinctly seen, and when it is found to polarize light may perhaps be still held to be keratose; where it does not, it may be termed *pseudokeratose* *. The tough, dark, keratose-like substance of the stem of *D. manaarense* exhibits decided polarizing effects, but the similar matter in *D. novizelanicum* does not.

The following must be added to the genus:—

4. DIRRHOPALUM CORIACEUM. (Plate XXIX. figs. 3–7.)

Isodictya coriacea, *Bowerbank, Mon. Brit. Spong.* iii. p. 228, pl. lxxvi. figs. 7–12.

It was obtained in Strangford Lough, Ireland. The original description is misleading, so I give the following supplementary account of the structure, made from Dr. Bowerbank's own preparations.

Skeleton.—Primary lines composed of (1) long, smooth acuate and (2) shorter spined acuates, the latter chiefly echinating the fibre by the lateral outward projection of their points at a very acute angle to it. Secondary lines, one spicule in length, composed of from one to three dumbbell-shaped spicules (3) at right angles to the primaries. Dermal *sarcode* granular, very dark; subjacent sarcode dark; a yellowish material unites the primary and secondary lines, but it does not polarize light.

Skeleton-spicules of three kinds:—(1) Large smooth acuates, slightly inflated, constricted above base, thickest immediately above this constriction; size variable, viz. ·317 to ·4434 by ·01268 to ·014 millim. (2) Smaller acuates thickly spined at base, very sparsely over the whole of the shaft; size ·158 by ·0079 millim. (3) Cylindrical dumbbell-shaped spicule; ends slightly inflated and well spined; the shaft less strongly spined (a converse impression is conveyed by fig. 12 of Mon. Brit. Spong. iii. pl. lxxiv.); size ·117 by ·0079 millim.

Flesh-spicules of two kinds:—(1) Tricurvate acerate, much more slender in proportion to its length than as given in Dr. Bowerbank's figure (*l. c.* fig. 9), and the ends carry a few minute

* I have experimented with the polariscope in order to discover, if possible, some real difference in optical properties between ordinary *sarcode* and *keratose* in the living matter of Sponges. The results are remarkable: thus the horny matter, mounted in balsam, of *Tuba* (a Chalinid), of *Rhizochalina oleracea*, *Hircinia lingua*, and *Euspongia virgultosa* polarizes light, while that of *Chalina finitima* does not; the sarcode was never found to polarize. Quekett ('Practical Treatise on the use of the Microscope,' edit. i. p. 448) ranks sponge-fibre with hoof, horn, and other ceratinous bodies as having this property of polarizing light.

spines; size ·19 by ·003167 millim. (2) Equianchorate; it has a web connecting the two lateral teeth all but the points; it thus approaches the form called "navicular" by Mr. Carter; it measures ·0158 millim. in length. Considerable numbers, grouped and single, occur in the mounted specimen of the dermis.

5. DIRRHOPALUM MICROCIONIDES.

Hymeraphia microcionides, *Carter, Ann. & Mag. N. H.* (4) xviii. p. 390.

I am indebted to Mr. Carter himself for pointing out the resemblance which this species bears to the genus *Dirrhopalum*. Its description, together with sketches which Mr. Carter has kindly furnished me, show that its structure is essentially the same as that of the other incrusting species which I have referred to the genus. A basal lamina contains the (1) doubly-headed cylindrical-spined spicules lying horizontally, also the equianchorate flesh-spicule; from the lamina project upwards (2) the long, smooth, and (3) the small, spined, and basally contracted acuate side by side. It does not appear that the smaller spined acuates are grouped in whorls round the larger ones, as in *D. clopetarium*. The colour is given as yellow, possibly owing to the presence of a ceratinous uniting substance, as in other *Dirrhopala*. The ends of the cylindrical spicule are slightly inflated, as I learn from Mr. Carter, and, as stated in his description, are more abundantly spined than the shaft. The locality is near Cape St. Vincent, the depth 374 fathoms. It belongs to the *gymnazon* section of the genus, but differs from the typical species, as at present known, in the absence of a tricurvate flesh-spicule.

6. DIRRHOPALUM MANAARENSE.

Dictyocylindrus manaarensis, *Carter, Ann. & Mag. N. H.* (5) vi. p. 37, pl. iv. fig. 1.

Mr. Carter has given me all the help which he possibly could with regard to its characters. An examination of mounted sections and fragments of a portion of the stem of the type specimen (for which I am indebted to Mr. Higgin, of the Liverpool Museum) shows that, as I had been led to suspect, the structure is essentially Dirrhopaline.

Skeleton.—In the *stem* a very horny primary fibre (probably less horny in the branches), running towards the surface, contains from one to three series of stout acuates (1), the points of the outermost of which project through the dermis, and it is sparingly

echinated by small acuates. A horny secondary fibre, at approximately right angles to them, connects the primary fibres and contains the dumbbells, which also occur sparingly in the primaries.

The *dermal skeleton* is formed of a reticulation of the dumbbell spicules lying generally in twos side by side, making angular meshes, their ends united by dark material polarizing light.

Of the *skeleton-spicules*:—(1) the smooth main acuate tapers slightly to its base, but otherwise agrees with Mr. Carter's description; size ·475 by ·0206 millim. (2) Short echinating acuate, smooth; is bent abruptly, like a scimitar, at about one third of its length from the sharp point; size ·114 by ·095 millim. (3) Fine acuate, smooth, slightly inflated basally, scattered over fibres and in dermis, probably young form of (1); size about ·3167 by ·006334 millim. (4) Dumbbell, with smooth curved shaft and distinct heads, very minutely microtuberculate rather than microspined (spines made too evident in Mr. Carter's figure for the scale on which it is drawn); heads of same diameter as middle of shaft; size ·234 by ·019 millim.

Flesh-spicules.—(1) Tricurvate, as given by Mr. Carter; size ·07 by ·0025 millim. (2) Equianchorate, navicular; shaft nearly straight; proximal edges of palms slightly bidentate; length ·019 millim.

Obs. I had occasion to examine the specimen to settle a doubt as to the identity of the species with *D. novizelanicum*, sp. n. (*infrà*), and so think it worth while giving these measurements and notes, which supplement and slightly correct Mr. Carter's careful description. It differs essentially from *D. novizelanicum* in the smoother and more finished condition of the dumbbell spicule, in the proportions and shape of the smaller acuate, and in differences in the measurements of most of the spicules. On the whole, in spite of its locality (Gulf of Manaar, Ceylon), it is not far removed in structure from the Floridan species *D. gymnazon*.

7. DIRRHOPALUM NOVIZELANICUM, sp. n. (Pl. XXIX. figs. 8–16.)

Branching cylindrical stems of constant diameter, viz. about 3 millim., having a delicate linear fucus for their axis; the branches sometimes anastomose. Apparently no rooting base; all extremities, both upper and lower, consisting of rounded points. Surface velvety, set with very slightly projecting ends of spicules. Texture elastic, slightly compressible. Colour in spirit dull umber-brown.

Vents. None apparent.

Main skeleton.—Spiculo-fibres containing a large proportion of pseudo-keratose; the primary fibres at right angles to surface, containing a single row of large, smooth acuate spicules (1), surrounded irregularly by two or three rows of shorter acuates (2), slightly spined basally, whose points project to the sides; a distinct margin of ceratinous material lies outside most of the spicules. The secondary fibres are numerous, irregular, formed of pseudo-ceratinous material, surrounding and showing distinct margins outside the dumbbell spicules (3), which occur, one or two together, in each fibre; secondary fibres about one spicule in length. Fine spinulate or supra-basally spinulate spicules (4) (probably young forms) scattered over primary fibres.

Dermal skeleton indefinite; consists of a reticulation of the dumbbell spicule, with the spinulates (4) scattered through it, perforated at intervals by the terminal long acuates (1) of the primary fibres.

Pseudo-ceratinous material dense, pale amber-yellow.

Sarcode very slightly granular, of almost the same colour.

Skeleton-spicules.—(1) Strong, smooth, slightly curved acuate, tapering to rounded base from a point at about 3 diameters from it and to sharp point from same place; size ·5 by ·025. (2) Smaller acuate, slightly curved, slightly constricted immediately above and very slightly microspined upon the base, and tapering to sharp point from just above the constriction; size ·2724 by ·0174. (3) Dumbbell spicules; shaft decidedly curved, and generally very sparsely microspined; ends well spined, separated from shaft by slight constriction; of about same diameter as middle of shaft; size ·177 by ·0158 millim.

Flesh-spicules.—(4) Long, straight, spinulate spicules, or with head just above base; various in size, viz. ·19 by ·0021 to ·36 by ·00475 millim. Probably young forms of skeleton-spicules. (5) Fine, decidedly tricurvate acuate, bow-shaped, tapering to fine points from middle, smooth; size ·06334 by ·0021. (6) Equianchorates, bipalmate, navicular; shaft almost straight; length ·019 millim.

Hab. Bay of Islands, north-eastern extremity of New Zealand (Antarctic Expedition). Depth ?

Examined in spirit and mounted in balsam from spirit.

Obs. One chief mass, 48 millim. long, with about eight branches given off at sharp angles from the single stem, and three or four fragments of similar character, all more or less growing over the

fucus above mentioned, occur in the Museum collection. It is doubtful whether they were naturally upright in growth, and whether they ever were rooted. The nearest described ally is apparently *D. gymnazon*, but the generally smaller size of the spicules distinguishes it; it is also near *D. manaarense* from Ceylon (*v. suprà*).

Systematic position of Dirrhopalum.

Prof. Sollas has already made the genus the type and sole occupant of a new "group" named PLOCAMIANINA. I am inclined to think that in so doing he has exaggerated the distinctness of the genus, and that *Clathria*, Schmidt (as based on *C. coralloides*, Schmidt, &c.), might with advantage be included in the group. The spiculation of the type species of that genus, as shown by the mounting in the British Museum, much resembles that of *Dirrhopalum*, consisting of a short cylindrical, two sizes of acuates (one of which is contracted at the base), a fine spinulate, and a navicular equianchorate; it has a well-marked horny fibre of distinctly echinonematous structure. More I cannot add from Schmidt's description; but in support of my view I would bring forward *Clathria rectangulosa*, Schmidt, and the species which, in my view, should be termed *Clathria Beani*, viz. *Isodictya Beanii*, Bowerbank, Mon. Brit. Spong. ii. p. 334, iii. pl. lviii. figs. 1–6.

Clathria rectangulosa has small acuate spicules tapering to their base, smooth cylindricals, subspinulate acuates, delicate equianchorates and tricurvates.

The British *C. Beani*, Bowerbank, agrees in the most extraordinary manner with *Dirrhopalum coriaceum* in the structure of its skeleton, and also in almost every particular of the forms and distribution of its spicules. It has a primary fibre composed of (1) large smooth acuate, surrounded by a group of (2) smaller ones, which are basally constricted; and a secondary fibre composed of (3) short, thick, entirely spined acuates, basally inflated, of almost the same diameter from the base to within a diameter of the point which abruptly terminates it. There are also a fine tricurvate and an equianchorate flesh-spicule. The spined acuate or spinulate (3) differs from the correspondingly placed dumbbell form of *D. coriaceum* by the addition of a *point* to one end, and by the absence, as a rule, of a well-marked *head* or swelling at the distal end; this end, however, is frequently marked off from the rest of the shaft by a slight neck, as if to form an incipient head,

and the point is sometimes so reduced in dimensions as to suggest that it might be readily lost altogether; in one instance it was found replaced by a blunted, but almost smooth extremity; thus the only serious difference between these species lies in the character of the pointed end of this spicule. It seems to me that we have here the very point of transition from *Clathria* to *Dirrhopalum*, and for these reasons I believe in a close affinity between the two genera. And this fact is the more interesting, as Prof. Schmidt has called attention to the British Sponge-fauna as consisting of an aggregation of indistinctly differentiated forms.

Sollas (Ann. & Mag. N. H. (5) iv. p. 49) found gradations between the dumbbell spicule of *D. plenum* and the spined and basally inflated acuate of the skeleton. May his transitional forms not show rather that the dumbbell spicule of the secondary fibre was originally like that of *D. Beani*, a spined spinulate or acuate, which is now only represented by these occasional reversions to the primitive type?

Existence of Dirrhopalum *in the Fossil State.*

This fact appears to be indicated with some probability by the figure given by Mr. Carter (Ann. & Mag. N. H. (4) vii. p. 133, pl. ix. fig. 50) of a spicule from the Upper Greensand of Haldon Hill, near Exeter, which corresponds in size to the average dimensions of the dumbbell spicules of *Dirrhopalum*. It has a smooth shaft, and smooth large extremities sharply distinguished from the shaft.

Prof. Sollas (*op. cit.* (5) vi. p. 392, pl. xx. fig. 46) figures and describes, as the basis of a provisional new genus and species called *Rhopaloconus tuberculatus*, a large subconical spicule rounded at each end, and covered with stout tubercles, just such as those of the two distinctive spicules of *D. clopetarium*, Schmidt. Its size, however, is ·95 by ·24 millim. It may perhaps represent an ancient divergence from the spined acuate form in the direction of a simple cylinder.

A. K. Zittel, in his memoir on the genus *Cœloptychium* (Abh. math.-phys. Kl. bayer. Akad. Wiss. xii. pt. iii. p. 1), figures, among a large number of spicules obtained from fossil Sponges of that genus, some (viz. pl. iv. figs. 20, 51, 65) which seem likely to have belonged to species of *Dirrhopalum* of the *clopetarium* section; they belong to the Upper Chalk. His fig. 17, a very remarkable form, with slight smooth shaft and large strongly

spined ends, might have been taken for an extreme form of dumbbell spicule but for Carter's observations, described and supported by Sollas (Ann. & Mag. N. H. (5) vi. p. 394), which tend to show it to be merely a foraminifer-cast.

Further, Mr. G. J. Hinde, in his inaugural dissertation entitled 'Fossil Sponge-Spicules from the Upper Chalk' (Munich, 1880), figures at pl. i. figs. 19, 20, two spicules of about the same contour as the "pegtop" form of *D. clopetarium*, but without tubercles, and of about three times the size of that spicule. The tubercles may have been lost by absorption, for the central canals are greatly enlarged. Fig. 22 of his paper represents a similar but slightly smaller spicule, provided, however, with tubercles tending, as in *D. clopetarium*, to disappear towards the point, which is broken off. Mr. Hinde refers to *D.* (*Plocamia*) *gymnazon* and *clopetarium* among other Sponges in connexion with some accompanying large acuates (p. 21, pl. i. figs. 10–15); but they can have, taken alone, no necessary connexion with those species, although occurring in conjunction with the conical types above mentioned, they seem to show very conclusively the existence of a *Dirrhopalum* of the *clopetarium* section in the seas of the Chalk period.

A. Rutot (Annales Soc. Malac. Belg. ix. pl. iii.), at fig. 7 figures a dumbbell spicule, at fig. 6 an elongated smooth pegtop form, and at fig. 39 *a* a cylindrical, from the "Grès" of the lower and middle Brussels strata (Eocene).

We have, then, for the distribution of the genus in time as at present known :—

	Recent.	Tertiary.	Upper Chalk.	Lower Chalk.	Greensand.
D. gymnazon group	*	*	...	...	*
D. clopetarium group...........	*	* ?	*	...	...

Part II.

Descriptions of two additional new Species of Dirrhopalum. By Prof. P. Martin Duncan.

During an examination of some débris which had been brought up by the dredge and tangles from the North Atlantic by H.M.S. 'Porcupine,' and from off the south-west coast of Spain in association with corals, I found an *Echinus*-spine, and also a darkly stained calice of a coral. Both were more or less covered with bristly sponges of an incrusting habit, and with very remarkably shaped, bent, cylindrical, terminally-inflated spicula forming the basis. A careful examination proved that they must be associated with Oscar Schmidt's genus *Plocamia*.

The first species to be described came up with a mass of the coral *Amphihelia ramea*, Sars, from the *Globigerina*-ooze in deep water from the North Atlantic; it covered an *Echinus*-spine.

The spine (Pl. XXIX. fig. 18), about two thirds of an inch in length, has been fractured; but what remains is covered with a very delicate incrustation of a very spiculiferous siliceous sponge. This is silvery white in colour, and shows neither oscules nor pores; but a considerable number of regular minute elevations are visible, out of the centre of each of which projects a large glassy spiculum. A low magnifying-power shows that the elevations are produced by whorls of spicula which radiate nearly at right angles from one spot around each large glassy spicule. The blunt ends of the radiating spicula are towards and in contact with the axial spicule; and their sharp terminations describe a circle, the periphery of which touches those of the neighbouring whorls around other large spicula.

The whorls have the spicula close together near the great or axial spicula, but they permit the sharp distal ends to be slightly separated. A sarcode fills up and covers all (Pl. XXIX. figs. 18 & 30).

Underneath this layer of whorled spicula there is a close layer of curved, cylindrical, globose-headed, entirely-spined spicula, which rests on the *Echinus*-spine. The large glassy axial spicula start from this layer and project at right angles to it (Pl. XXIX. fig. 30).

There are several kinds of spicula, which may be considered under the heads of those of the outer skeleton, the body, and the derm.

Outer Skeleton.—Large and smaller attenuato-acuates basally spined.

Subfusiform acuates with ovoid basal inflations, minutely spinulate.

Body. — Curved, cylindrico-globose-headed, entirely-spined spicula.

Derm.—Cylindrical, cylindrical laterally spined, linear cylindrical minute, and minute fusiform spicula.

One large bihamate spiculum is amongst a whorl of spicula; but as it is in company with a coccolith, it is probably a foreign body.

Description of the Spicula.—The large skeleton-spicula, axial to the whorls, few in number, protrude at right angles to the mass of the sponge and extend beyond any of the others, forming a regular series of nearly equidistant sharp projections, glassy in appearance. They are slightly bent, and gradually taper from their rounded base (which is placed amongst the cylindrical curved and bossed spicula of the body) to their apex (which becomes sharp rather suddenly). The rounded head is minutely and scantily spinulate and is about $\frac{1}{300}$ inch in diameter, and the whole spicule is $\frac{1}{20}$ inch long (Pl. XXIX. figs. 28 & 30). Sometimes very minute spinules exist for some distance up the spicule, which, moreover, has a minute axial canal. Some others (attenuato-acuates), smaller than these, but having the same shape and direction, exist, and they are evidently correspondingly immature spicula.

The whorled spicula (Pl. XXIX. figs. 24–27) are very slender, straight, and have a basal inflation of the ovispinulate type. This oviform enlargement is excessively minutely spinulate, and joins the shaft at a constricted neck. The shaft is fusiform, but the swelling is in the basal third of the spicule; thence the spicule becomes slenderer, and ends rather suddenly by becoming sharp-pointed. In some instances there are a few very minute point-like spines on the shaft near the neck. Some basal inflations are very ovoid, others are more globular; but in every instance the external or terminal portion is narrower than that just within and nearer the neck. The usual length of these spicula is $\frac{1}{100}$ inch, and the breadth $\frac{1}{3000}$ inch. The swelling of the shaft and the constricted neck and small-spined ovoid base are very distinctive. They are very numerous, and are placed in one or two whorled layers; the bases are towards the

great attenuato-acuates, and the shafts radiate at nearly right angles. The oviform bases are in contact at their sides with their fellows, and at their ends with the great spine, which they surround (Pl. XXIX. fig. 30). The axial canal is not to be seen.

The body-spicula in contact with the spine of the *Echinus* are short, curved, cylindrical, having globose or subhemispherical ends, slightly constricted where they join the body of the spicule. They are entirely bluntly spined. The spinulation is small and close on the rounded ends; but there is less of it on the constricted necks, and it is wider apart, stouter, and longer on the body. The boss-shaped ends are wider than the body (Pl. XXIX. fig. 19). Usually a large axial canal is visible in these spicula, and it extends far into the heads of the elongated curved dumb-bells. These spicula form one or two layers, one above the other; they are placed close together, without order as regards their direction; but there is some diversity in their size and shape, owing mainly to age.

A typical spiculum of this kind has a perfectly cylindrical body, not more swollen out in any part than elsewhere; the cylinder, slightly bent, is narrower than the terminal bosses, and is more than double the length of one of them.

The blunt spinulation surrounding the whole surface is irregular, distant, and the tops of the projections, which differ in length, are blunt.

Varieties.—Spicula of the same length as the type, but having the boss more spherical and the constriction of the neck more decided, the spinules being scanty on the neck and larger than usual on the body. Spicula with one boss perfect and the other less so or smaller.

In all, the spinulation of the boss-like ends is minute and in a series of concentric circles; but there is no order in that of the curved stems, where it is larger.

The diameter of these body-spicula is $\frac{1}{1000}$ inch, and the length $\frac{1}{200}$ inch.

The sarcode covered the radiating whorled spicula and the spaces between them; it closed in the spaces or interstices between the numerous whorls, and it extended further out, to the tops of the long skeletal spicula. The spicula of the derm are few in number; and some are apparently quite superficial. Three kinds are to be noticed; but one appears to be a young form. One is a minute cylindrical rod; another is of the same

diameter, but is four or five lines longer (Pl. XXIX. fig. 29). The third kind is a very minute fusiform spicule, sharper at one end than at the other.

Amongst the whorls of spicula are some differing in shape and dimensions from the majority. They are placed between the radiating skeletal elements, and are free in the sarcode which unites the whole. They are much shorter and slenderer than the others, and are cylindrical and very slightly curved at one end. Some of them are about one third the diameter of the whorled spicula, and others are less than one sixth, appearing to be almost linear under a quarter-of-an-inch object-glass (Pl. XXIX. figs. 22, 23). Larger than these, but still not equalling in breadth the common whorled spicula, are some cylindrical spicules with slightly bent ends, the shaft being very sparingly and minutely spinulate, but not the end (Pl. XXIX. fig. 21). Larger cylindrical spicula are rare; they are straight, and minutely and sparsely spined, and only on the stem; their diameter is greater than that of the whorled series, and is about equal to that of the curved cylindrical body-spicula (Pl. XXIX. fig. 20).

The second species was found on the septum of a dead manganese-covered coral, dredged up from 1095 fathoms, the locality being off the coast of Spain, No. 17 dredging, N. lat. 39° 30′, W. long. 9° 39′.

The sponge covers a large septum, is of a dirty-white colour, and is hirsute, with separate long acuates, which arise as it were out of a stubble of smaller spicula, grouped so as to radiate upwards and outwards, from near the base of the long spicula. Each long spiculum has thus a group of shorter ones around it, assuming the direction just mentioned. On separating these structural elements from the coral, a layer of large, curved, or bent, or nearly straight, cylindrical spicula, with one well-developed globose head at least, becomes visible; they rest on a membranous-looking derm, which is closely applied to the dark-coloured coral-surface. No oscules or pores can be distinguished, and there is no keratose fibre.

The curved body-spicula (Pl. XXIX. fig. 34) are large, and often $\frac{1}{100}$ inch in length; they are, in some instances, symmetrically curved, and have a rounded globose termination at either end, which is joined to the body by a very slight constriction. There is a small and close spinulation on the ends, and a larger and

scantier on the body. A second form of body-spicule has a less decided curvature and but one globose end, the other being a mere rounding of the cylindrical body. The spinulation resembles that of the first type (Pl. XXIX. fig. 35). A third is longer than the others, is bent more or less like a boomerang, has a globose process at one end, and a narrow, cylindrical, and rounded termination at the other (Pl. XXIX. fig. 36). The spinulation is scanty on the body. There are intermediate shapes, and on some there is a large spinule, in particular, on the cylindrical body (Pl. XXIX. fig. 37). These spicula are placed without order on the surface of the coral in one layer, and are not very close. Length $\frac{1}{300}$ to $\frac{1}{100}$ inch, thickness $\frac{1}{1300}$ inch.

The long acuates, straight or sometimes slightly bent, project well beyond the other spicula, and were covered with sarcode. Their bases, rounded off and very minutely spinulate, are as thick as one of the curved spicula just noticed; they slope gradually to a sharp point, and their axial canal is very manifest near the base (Pl. XXIX. figs. 32, 33). The radiating spicula are very numerous and are arranged in bundles, the faintly enormispinulate heads of the spicula being close together and surrounding the stout long and large acuates. The shafts of the spicula are slightly swollen in the first third, so that they are more or less fusiform, and the point suddenly becomes sharp, like a straight sword. The shafts project upwards and slightly outwards, and their points form a circle around the acuate spicule and tolerably close to it (Pl. XXIX. fig. 31). The heads of the spicula (length $\frac{1}{130}$ to $\frac{1}{100}$ inch) are remarkable in shape; there is a cylindrical swelling with a short neck, and then there is a projecting end, which is longer than broad, cylindrical, and rounded. An excessively delicate and scanty spinulation is seen on the cylindrical part and also on the rounded end (Pl. XXIX. fig. 39). There are no other spicula. The sarcodic structures enveloped the whole, and were stretched out to the tops of the long acuates; there was a definite basal membrane.

It is evident that this form is closely allied to the first species I have described, from which it is distinguished by the shape of the deeply-seated spicula and the direction of the enormispinulates. It is possible that these distinctions may be racial; but, under existing circumstances, it is best to separate the forms specifically.

The first species I have named *Dirrhopalum Carteri*, and the second *Dirrhopalum hystrix*.

Part III.

On some Sponges of the Order Echinonemata.

By S. O. Ridley.

The concluding part of this paper deals with an hitherto unrecognized generic type, which may be assigned to the

Order ECHINONEMATA, *Carter.*

Family Axinellida, *Carter.*

Group Multiformia, *Carter.*

Echinodictyum *, n. gen.—Sponge erect; cup-shaped or ramose. Skeleton formed of spicules united into distinct coherent fibres. From the fibre project at right angles short strongly-spined cylindrical spicules tapering from their attached ends. Spicules of fibre smooth, acerate (doubly pointed). No special flesh-spicules.

Type *Spongia bilamellata*, Lamarck, Ann. Mus. Hist. Nat. xx. p. 434.

Obs. The nearest affinities of this genus appear to be with *Dictyocylindrus*, Bowerbank, s. str., *i.e.* with those species which have a more or less distinct firmer axis and echinated fibre, combined with a spiculation of smooth acuates and acerates in the fibre, smooth acuates and spined cylindricals, or blunt acuates echinating it, and no minute flesh-spicules (e.g. *Dictyocylindrus hispidus*, Bowk., *Axinella damicornis*, Schmidt, *D. Pykei* and *laciniatus*, Carter). It differs from *Dictyocylindrus* mainly in the absence of the smooth acuates, usually so abundant in that genus, and in the much greater definiteness of the fibre. It perhaps connects *Dictyocylindrus* by these characters with the *Ectyonida* (Carter).

As the typical species has never been described from a microscopic examination or figured, and as such fine specimens are available, I append a full description with figures.

Echinodictyum bilamellatum. (Plate XXVIII. figs. 1–6.)

Spongia bilamellata, *Lamarck, Ann. Mus. Hist. Nat.* xx. p. 434; *Anim. s. Vert.* (2) ii. p. 556.

Sponge erect, turbinate, expanded, or compressed; the margin of the cup is prolonged in adult specimens into one or more broad expansions; a short pedicel. Internal surface of cup smooth (occasionally undulating), bearing the numerous scattered vents. External surface exfoliating so as to form obscure longitudinal ridges, which, together with the intermediate spaces, grow out into larger or smaller rounded excrescences, composed of reticulate fibrous tissue. Texture of inner surface dense, that of outer loose; in dry state firm, subelastic. Colour in dry state pale brown.

* ἐχῖνος, a sea-urchin or hedgehog, and δίκτυον, a net.

Vents numerous, apparently only on inner surface of cup; round; diameter 1 to 3 mm.

Main Skeleton.—Arrangement rather irregular. The stout, somewhat flexuous primary fibres run approximately at right angles to the surface; they are connected, usually at short (·2 to ·43 mm.) intervals, by secondary fibres, which run at angles varying from 45° to 90°, with the primaries, and are often curved. Pseudo-ceratinous (*antea*, p. 481) material pale yellowish brown in upper part of sponge, extending beyond the margins of the skeleton-spicules; does not polarize light. Primary fibres ending on surface by anastomosis with a dermal set of secondaries, or projecting beyond it to a distance not exceeding ·4 mm. on the inner, 1·5 mm. on the outer surface of sponge. Both primary and secondary fibres filled with parallel smooth acuates, apparently of two sizes; both generally 8 to 15 spicules broad, and both echinated at short intervals by single-spined cylindrical spicules, which project at right angles to the surface of the fibre, and are attached by their extreme base.

Dermis.—Fibres very tortuous, stout, forming meshes of very various size and generally rounded outline; echinated by large numbers of the cylindrical spicule.

Sarcode.—In dried state transparent yellowish brown; that of the surface, however, almost covered by minute patches of a granular reddish pigment.

Skeleton-spicules of two kinds:—(1) Smooth acerate (pointed at both ends), more or less bent, rather sharply, tapering to sharp points from within 3 diameters of the ends; size from ·26 to ·32 by ·014 mm.; occurring in all the fibres, and occasionally free in sarcode near fibre. (2) As no. 1, but size from ·19 to ·25 by ·011 to ·0127 mm.; form the greater part of the fibre.

Echinating spicule.—Cylindrical, blunt at both ends, tapering from attached end, which is about twice the diameter of free end; covered with spines, especially thickly at ends; spines prominent, sharp, the basal ones projecting at right angles to the axis of spicule, the remainder curved towards base; size ·1 to ·12 mm. by ·0095 to ·0126 mm.

Hab. "Southern Ocean" (*Péron & Lesueur ap. Lamarck*); pearl-oyster bed on N.W. coast of Australia, and W. Australia? (*Brit. Mus. coll.*).

Examined. Dry and in balsam.

Obs. Two specimens of this species are known—the type specimen in the Paris Museum (*cf.* Lamarck, *loc. cit.*), and a fine specimen recently purchased for the British-Museum collection.

The latter is a remarkably fine and attractive specimen; has

the shape of corals of the genus *Turbinaria*, viz. an open cup; its short pedicel measures about $2\frac{1}{4}$ inches in maximum diameter.

Maximum diameter of cup about 12 inches, height 7 inches; thickness of wall near edge $\frac{1}{4}$ to $\frac{1}{2}$ inch (6 to 12 mm.). It is attached to the upper valve of a pearl-oyster (*Avicula margaritifera*), which was evidently alive when taken from the sea, in spite of the presence of its bulky messmate.

The occurrence of a third specimen is certified by a slide of spicules in the Museum collection, which, as it was presented by Mr. G. Clifton, to whom the Bowerbankian collection of foreign Sponges owes an immense series of very fine specimens from Fremantle, S.W. Australia, probably was made from a sponge obtained in that region.

As the Museum has been fortunate enough to obtain (owing to the liberality of M. E. Perrier, of the Museum at the Jardin des Plantes, Paris) a fragment of Lamarck's original type specimen, I am enabled to give a comparative Table of some of the chief characters of these three specimens, which will afford some idea of the range of variation within the species.

Echinodictyum bilamellatum.	Type, "Southern Ocean."	B.M. spec., N.W. Australia.	Mr. Clifton's spec., W. Australia?
External form	Infundibular at base, edges prolonged into two lamellæ. Outer surface roughened ("scrobiculated").	Infundibular, one side prolonged as an everted lip. Outer surface roughened ("scrobiculated").	?
Vents	On inner surface 1 or more mm. in diam.	On inner surface 1 to 3 mm. in diam.	?
Colour in dry state:	Pale yellowish brown.	Pale yellowish brown.	?
Primary skeleton-fibre (inner surface of sponge):	6 to 10 spicules thick.	8 to 15 spicules thick.	?
Secondary skeleton-fibre:	6 to 10 spicules thick.	8 to 15 spicules thick.	?
Length of primary fibre between the secondaries (inner surface of sponge):	·21 to ·28 mm.	·28 to ·43 mm.	?
Large smooth acerate spicule:	·266 by ·014 mm.	Shape as in type. ·304 by ·014 mm.	Shape as in type. ·3167 by ·014 mm.
Smaller smooth acerate:	·19 by ·01268 mm.	Rather more abruptly pointed than in type. ·2216 by ·011 mm.	Rather more abruptly pointed than in type. ·2534 by ·01268 mm.
Spined cylindrical...	Spines least numerous just above base, ·108 by ·0095 mm.	Shape &c. as in type. ·114 by ·0095 mm.	Spines coarser and equally distributed all over. ·108 by ·01268 mm.

Echinodictyum nervosum. (Plate XXVIII. figs. 7–10.)

Spongia nervosa, *Lamarck?*, *Ann. Mus. Hist. Nat. Paris*, xx. p. 450; *Anim. s. Vert.* (2) ii. p. 567.

Spongia cancellata, *Lamarck?*, *Ann. Mus. Hist. Nat. Paris*, xx. p. 456; *Anim. s. Vert.* (2) ii. p. 571.

Sponge branched in one plane from almost obsolete stem; branches long, anastomosing at points, which are generally adjacent in the various branches; near base irregularly cylindrical, becoming flattened higher up; apices digitiform, adjacent edges narrow, knife-like. Surface normally covered by dense white incrustation; minutely reticulate on back, and minutely hispid in front of frond when this is removed. Texture hardish; it is slightly elastic, but easily broken. Colour in dried state pale yellowish white.

Vents numerous, in one side only of frond (the front), scattered, numerous, 1 to 2 mm. in diameter, indistinctly defined. Pores?

Main skeleton composed of spiculo-fibre, in which the smooth acerate spicules almost entirely conceal the ceratinous uniting substance; primary fibres straight, at right angles to surface, from 3 to 6 spicules in diameter; secondary fibres short, about 1 spicule long and 2 to 3 broad, connecting primaries at various angles; both sets of fibres sparsely echinated by single, short, entirely-spined cylindrical spicules.

Dermal skeleton consisting of broad, irregularly anastomosing tracts of smooth acuate spicules slightly echinated by spined spicules.

Sarcode transparent. *Ceratinous material* amber-yellow in basal skeleton, almost colourless in branches; polarizes light.

Skeleton-spicules of one kind:—Smooth stout acerate, bent at a slight angle, and tapering to sharp points from about the centre (as occasional variations they may have one or both ends rounded off); size ·39 (occasionally ·46) by ·03167 (occasionally ·038) mm.

Echinating spicule short, straight, spined, cylindrical, tapering slightly from rounded base (which is slightly inflated in some cases) to distal rounded end; spines abundant, strong, and recurvate over distal half, slighter and curved towards apex on base, very slight or absent on part immediately above the base; size ·114 by ·0174 mm.

Hab. S.E. coast of Arabia (*Carter*) (Indian Ocean?, *Lamarck*).

Examined. Dry and mounted in balsam.

Obs. The dry specimen in the Bowerbank collection is 9 inches high, and about the same in breadth at the broadest part.

Another species of this genus is known to me, to which I hope to refer on some future occasion.

DESCRIPTION OF THE PLATES.

Plate XXVIII.

Figs. 1–6. *Echinodictyum bilamellatum.* 1. Portion of surface of inner aspect of sponge, from type in Paris Museum, × 38 diam. 2. External part of section perpendicular to inner (upper) surface of cup, × 38 diam. (from the British-Museum specimen from N.W. Australia). 3 & 4. Skeleton acerate spicules, × 68 diam., from type specimen. 5. Spined cylindrical echinating spicule, × 370 diam., from type specimen. 6. The British-Museum sponge (*E. bilamellatum*) from N.W. Australia, reduced to one third nat. size.

7–10. *Echinodictyum nervosum.* 7. Part of surface, × 50 diam. 8. Part of section perpendicular to branch, × 50 diam. 9. Skeleton acerate spicule, × 68 diam. 10. Spined cylindrical spicule, × 370 diam.

Plate XXIX.

Figs. 1 & 2. *Dirrhopalum gymnazon.* 1. Tricurvate flesh-spicule, × 370 diam. 2. Equianchorate flesh-spicule, × 370 diam.

3–7. *Dirrhopalum coriaceum.* 3. Equianchorate flesh-spicule, × 370 diam. 4. Dumbbell spicule, × 370 diam. 5. Tricurvate flesh-spicule, × 185 diam. 6. Smaller (spined) acuate spicule, × 185 diam. 7. Head of larger (smooth) acuate, × 370 diam.

8–17. *Dirrhopalum novizelanicum.* 8. Large skeleton acuate (no. 1), × 68 diam.? 9. Smaller skeleton acuate (no. 2), × 68 diam. 10. The same, head, × 370 diam. 11 & 12. Fine spinulates of flesh (no. 4), × 68 diam. 13. Equianchorate flesh-spicule, × 370 diam. 14. Tricurvate flesh-spicule, × 370 diam. 15. Dumbbell spicule, × 370 diam. 16. Portion of surface, × 30 diam. 17. Section across long axis of sponge, × 30 diam.

18–30 *a*. *Dirrhopalum Carteri.* 18. The sponge, around portion of an *Echinus*-spine, nat. size. 19. Curved cylindrical, globose-headed, entirely-spined axial spicule, magnified. 20. Cylindrical straight spinulate, magnified. 21. Cylindrical curved spinulate, magnified. 22 & 23. Small cylindrical curved spicules, magnified. 24. Ovispinulate subfusiform whorl-spicule, magnified. 25–27. Different forms of head of 24, more highly magnified. 28. Base of the large acuate, magnified. 29. Three minute cylindrical derm-spicules, magnified. 30. Diagram of the position of the spicules 19, 24, 28. 30 *a*. A whorl of spicules round a large acuate one, which is seen in section, magnified.

31–39. *Dirrhopalum hystrix*, magnified. 31. Diagram of the position of the spicules. 32 & 33. Base of long acuate, magnified, showing a plain ending and terminal spinulation respectively. 34. Curved dirrhopalate spicule, magnified. 35. Curved cylindrical spicule, magnified. 36. Spicule with an irregular bend, and only one globose end, magnified. 37. Curved cylindrical bent spicule with large spinule on it, magnified. 38. Spicule with an irregular bend and only one globose end, magnified. 39. Enormispinulate, magnified.

INDEX.

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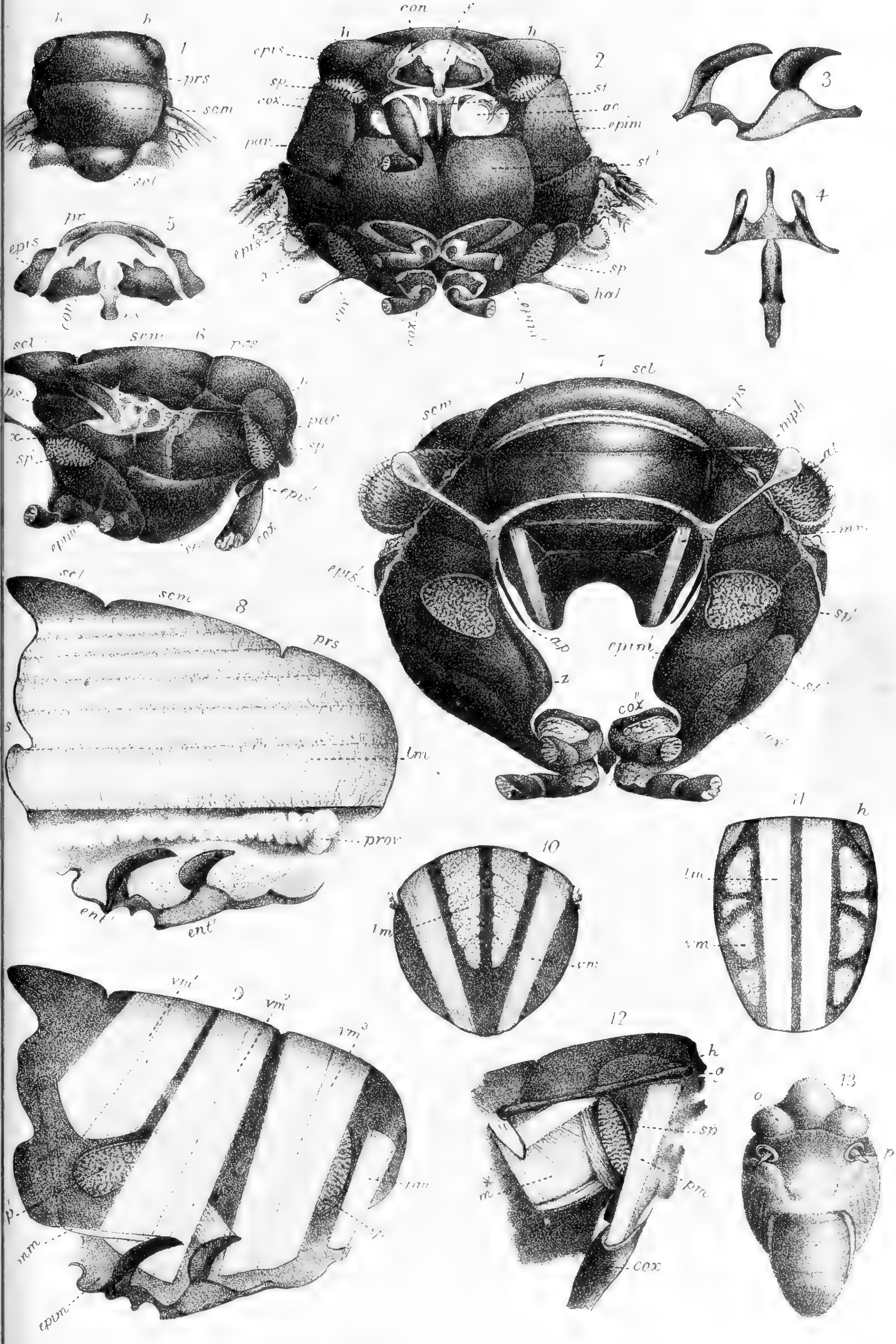
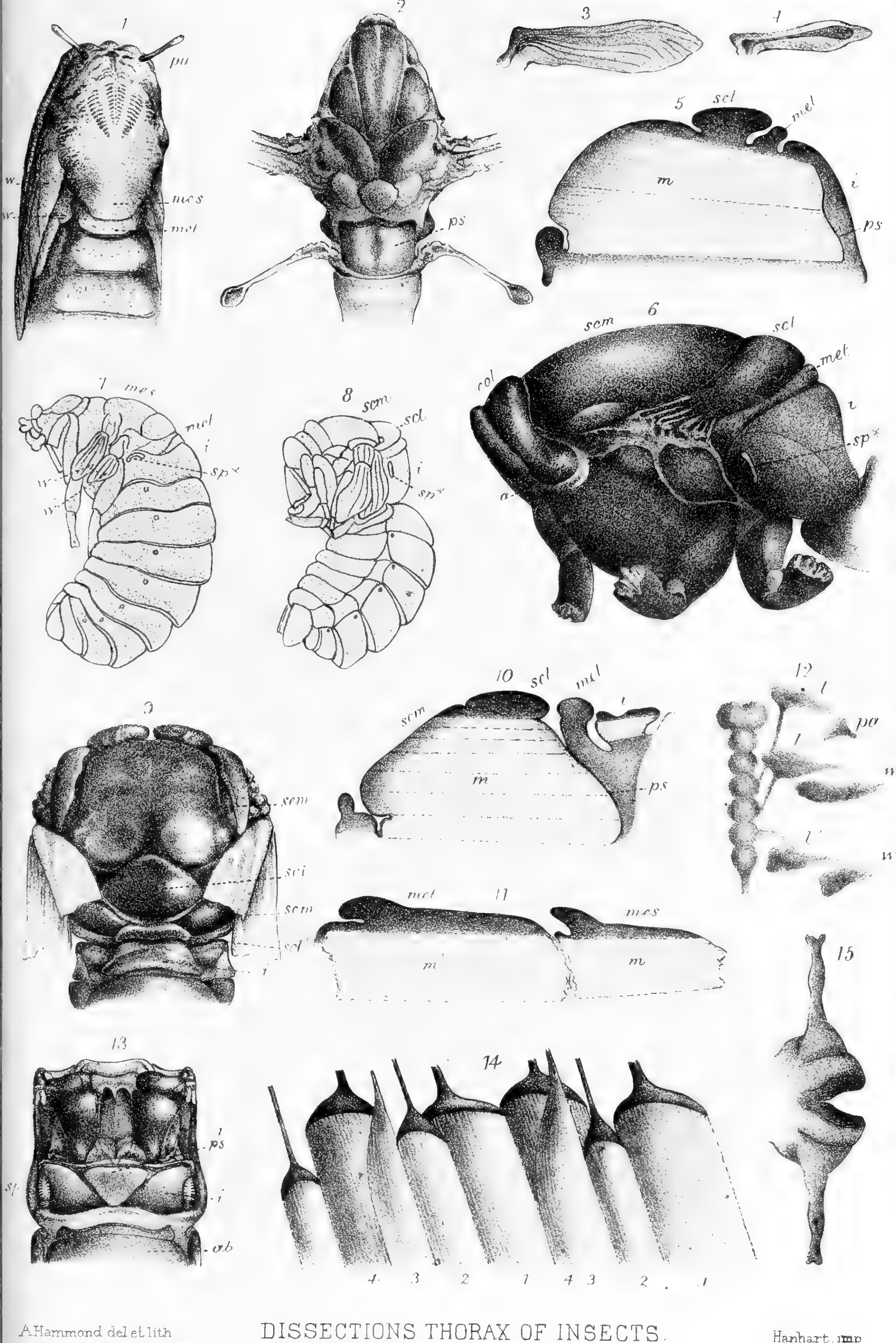


A Hammond del et lith   DISSECTIONS THORAX OF BLOW-FLY.   Hanhart imp



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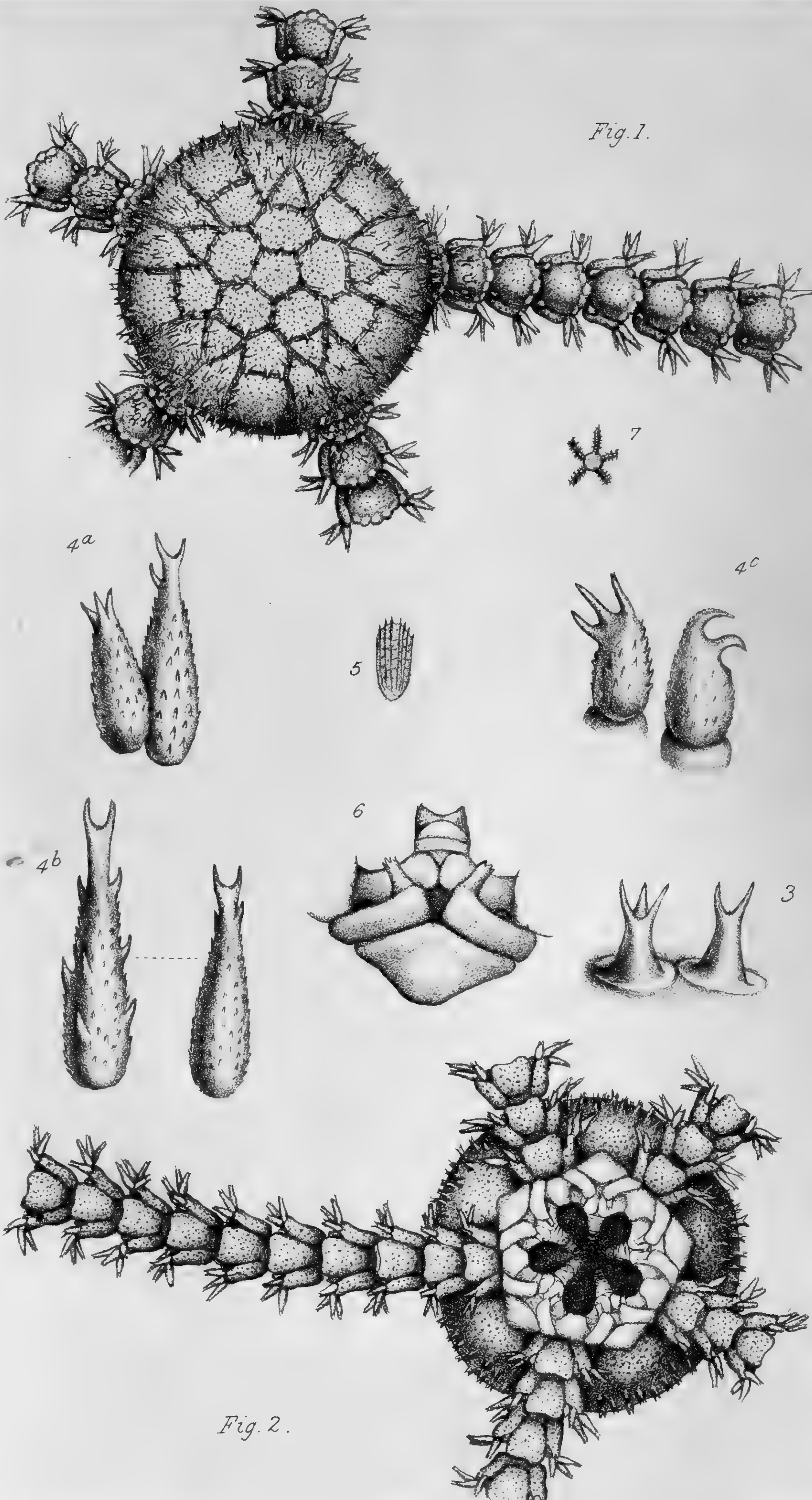

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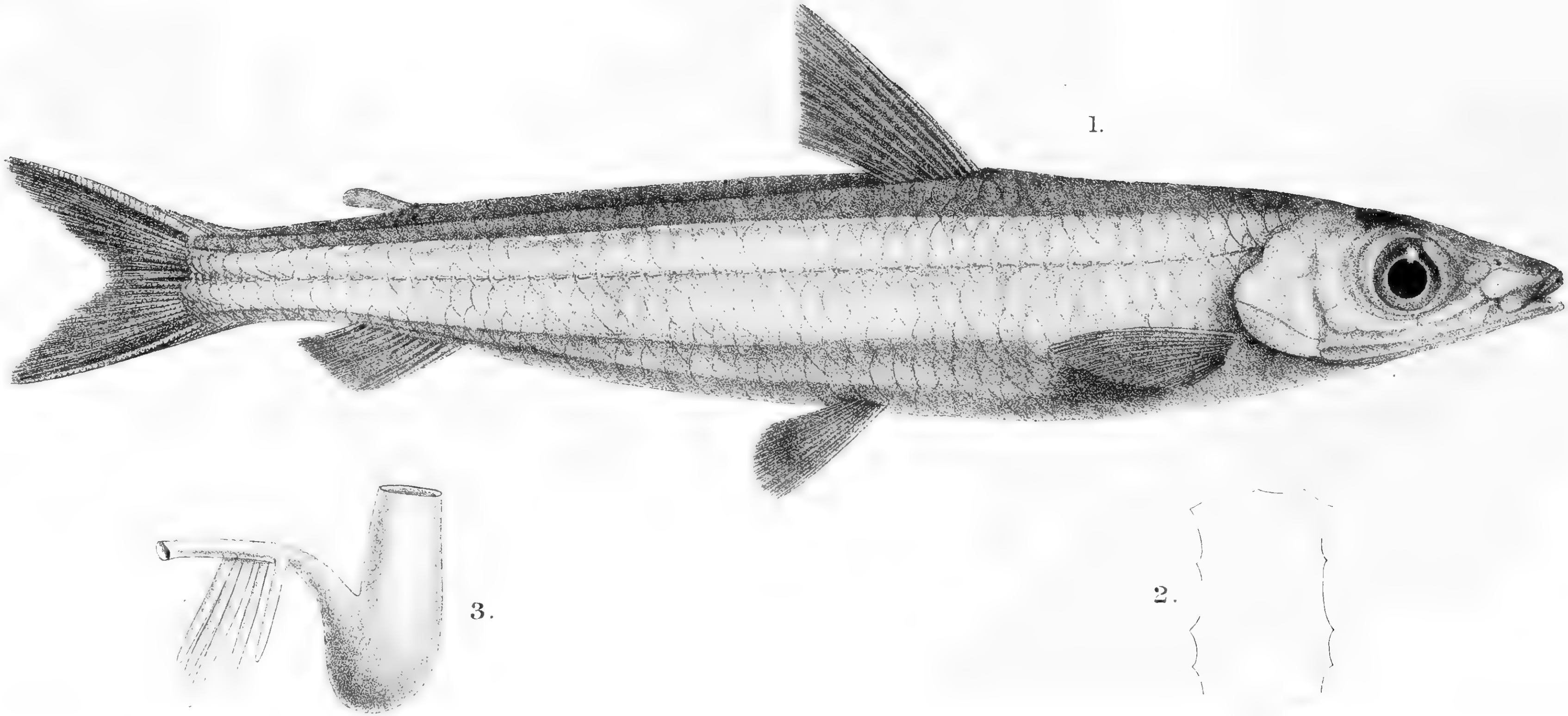
POLYPHOLIS ECHINATA, *Duncan*.

F. Day. del.



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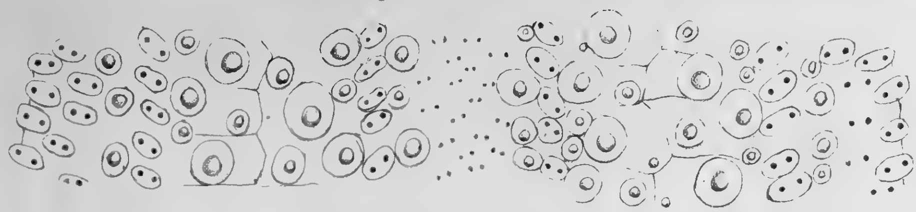
ARGENTINA SPHYRÆNA *Linn*.

Fig. 6.



Amblypneustes griseus.

Fig. 4.

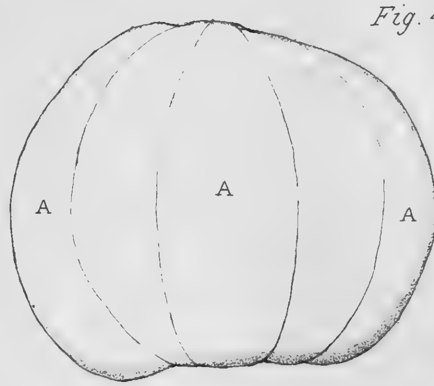


Fig 5.

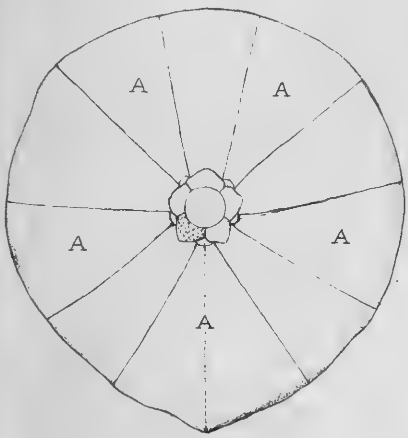


Fig. 1.

A. formosus.

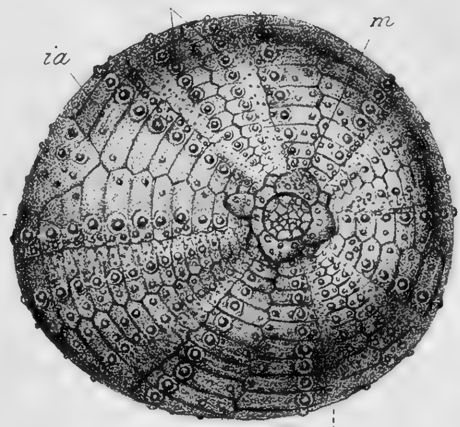
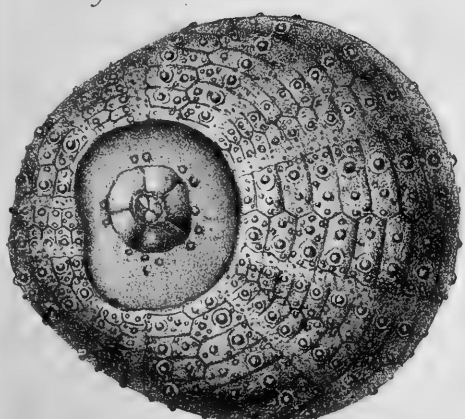


Fig. 2.



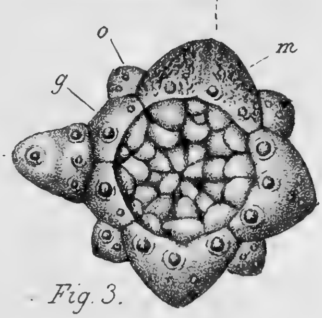


Fig. 3.

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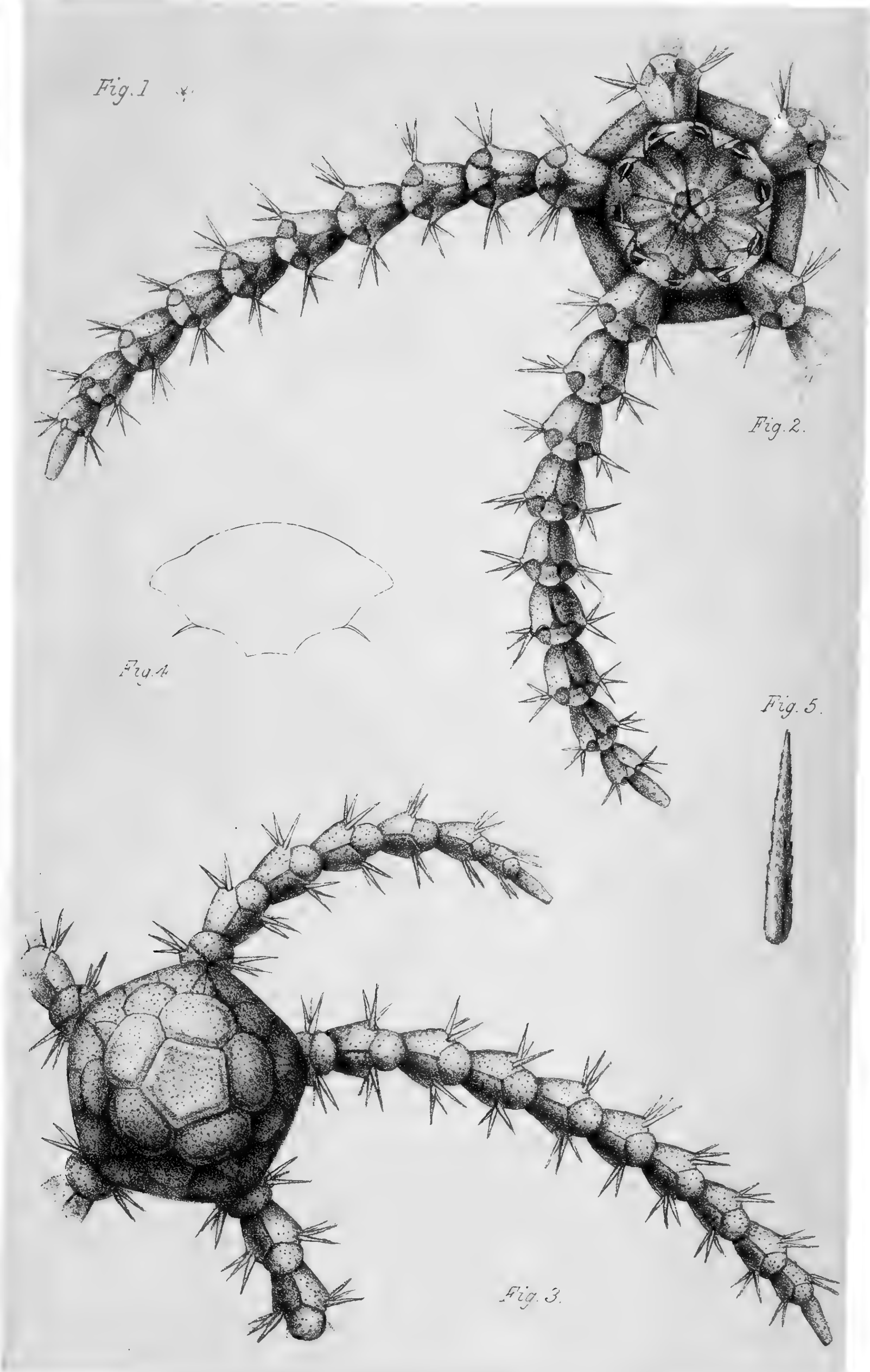
ABNORMAL ECHINODERMS.



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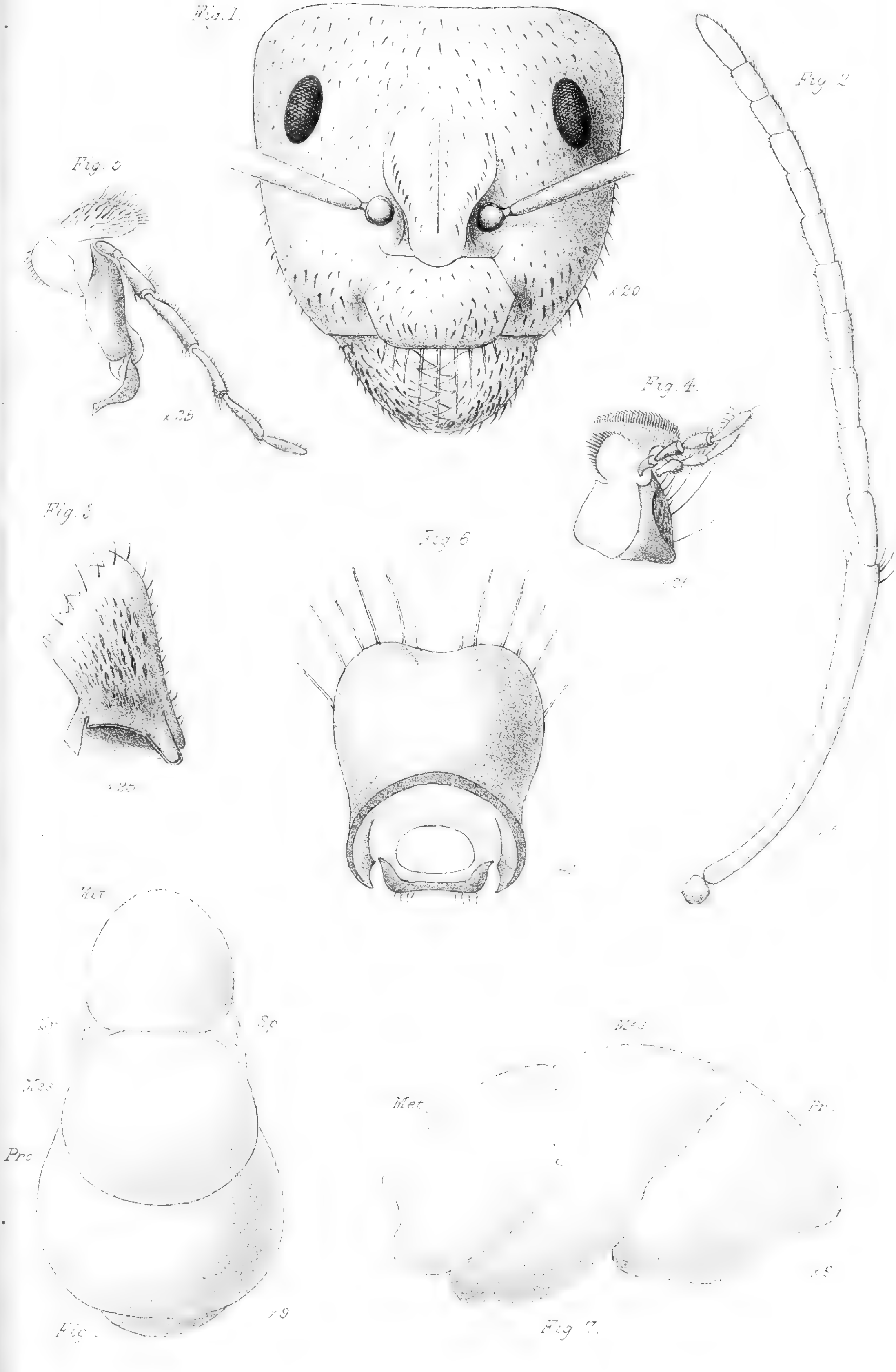
HEMIPHOLIS WALLICHII, *Duncan*.

C. Achilles. lith.

Mintern Bro's imp.

SCOMBER SCOMBER *Linn* (*var* S. PUNCTATUS *Couch*).



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CAMPONOTUS INFLATUS.

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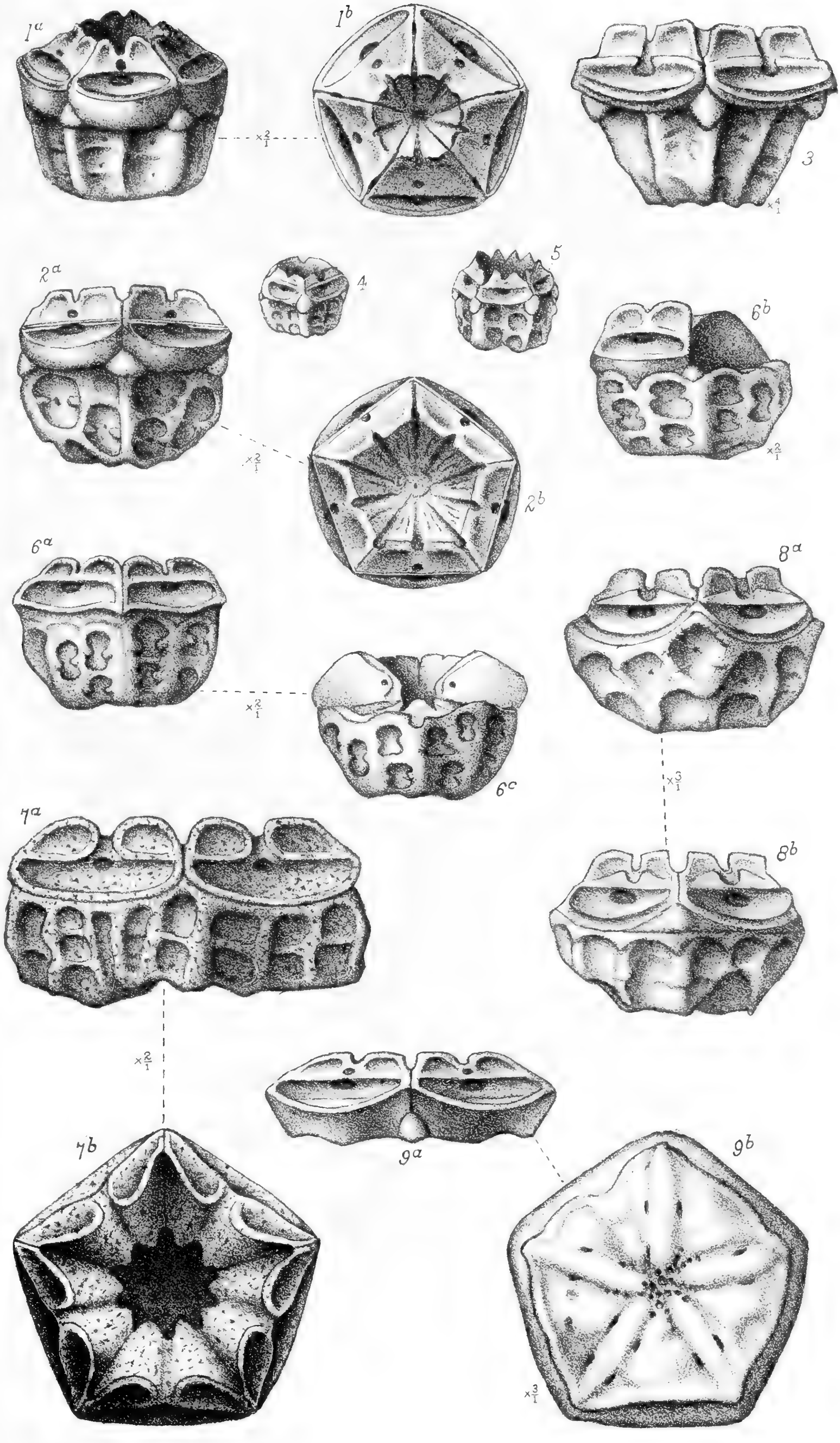

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(=ANTEDON & ACTINOMETRA.)

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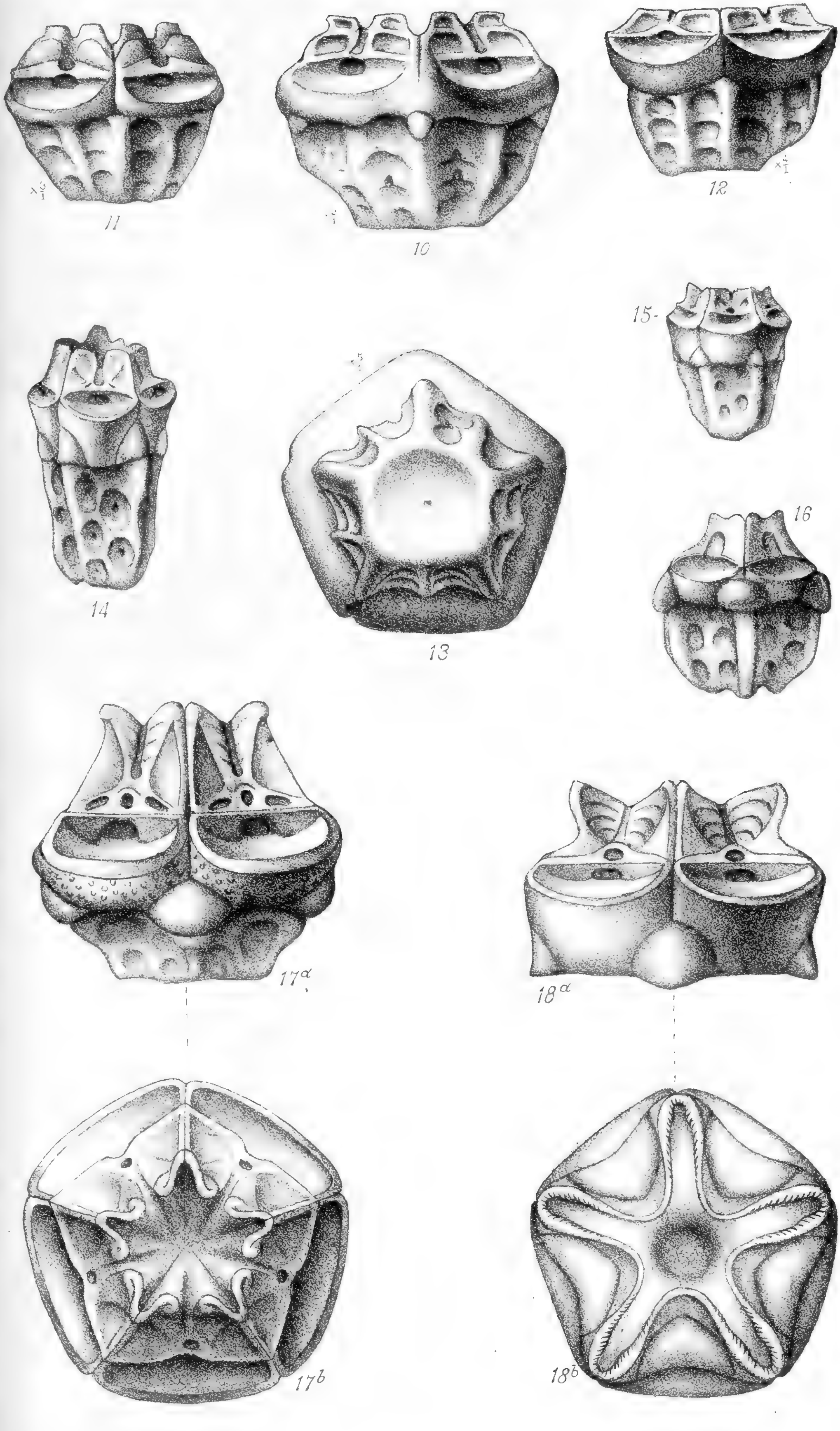
H Carpenter.



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SPECIES OF SOLANOCRINUS (ANTEDON)

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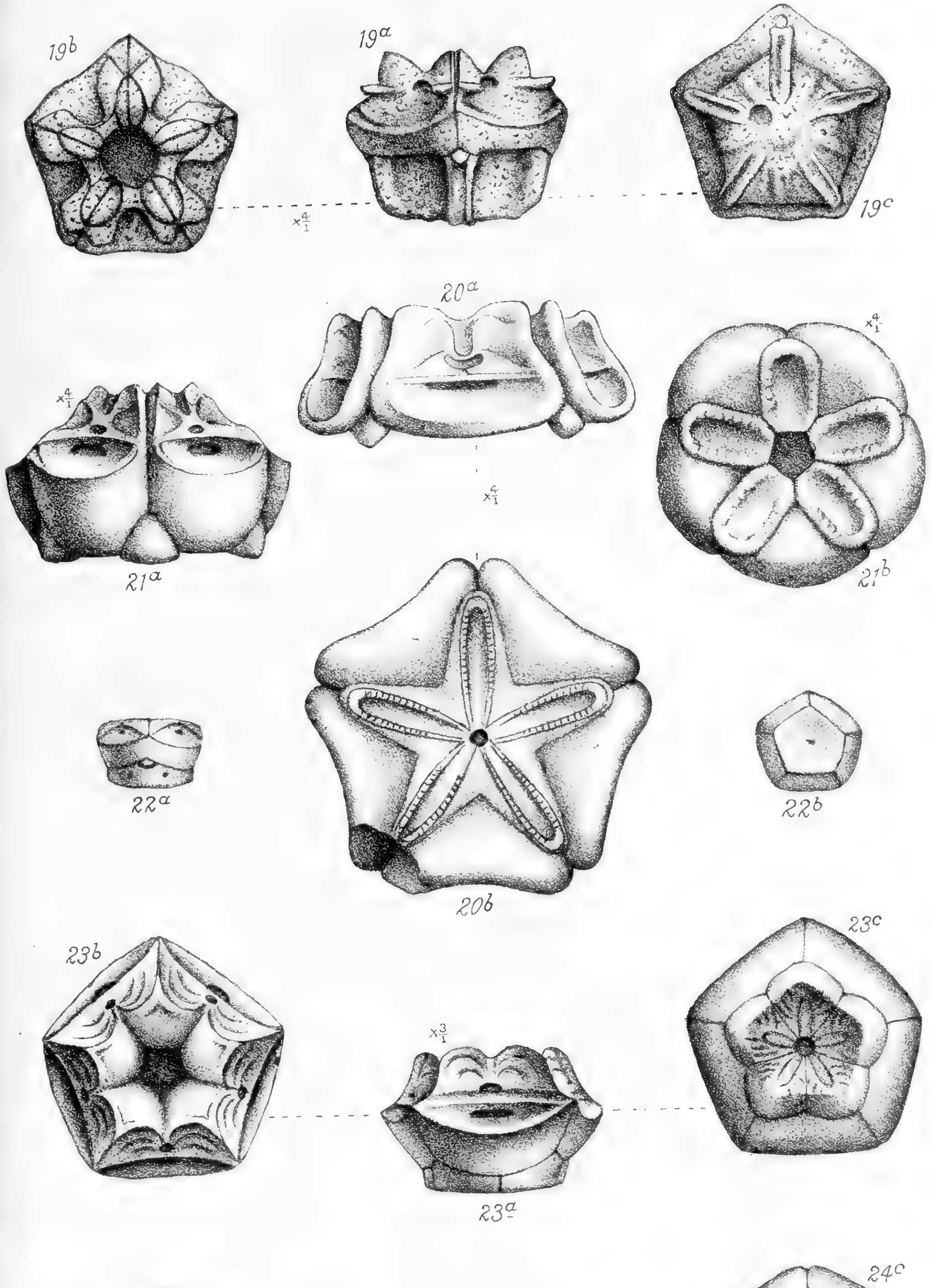
H. Carpenter



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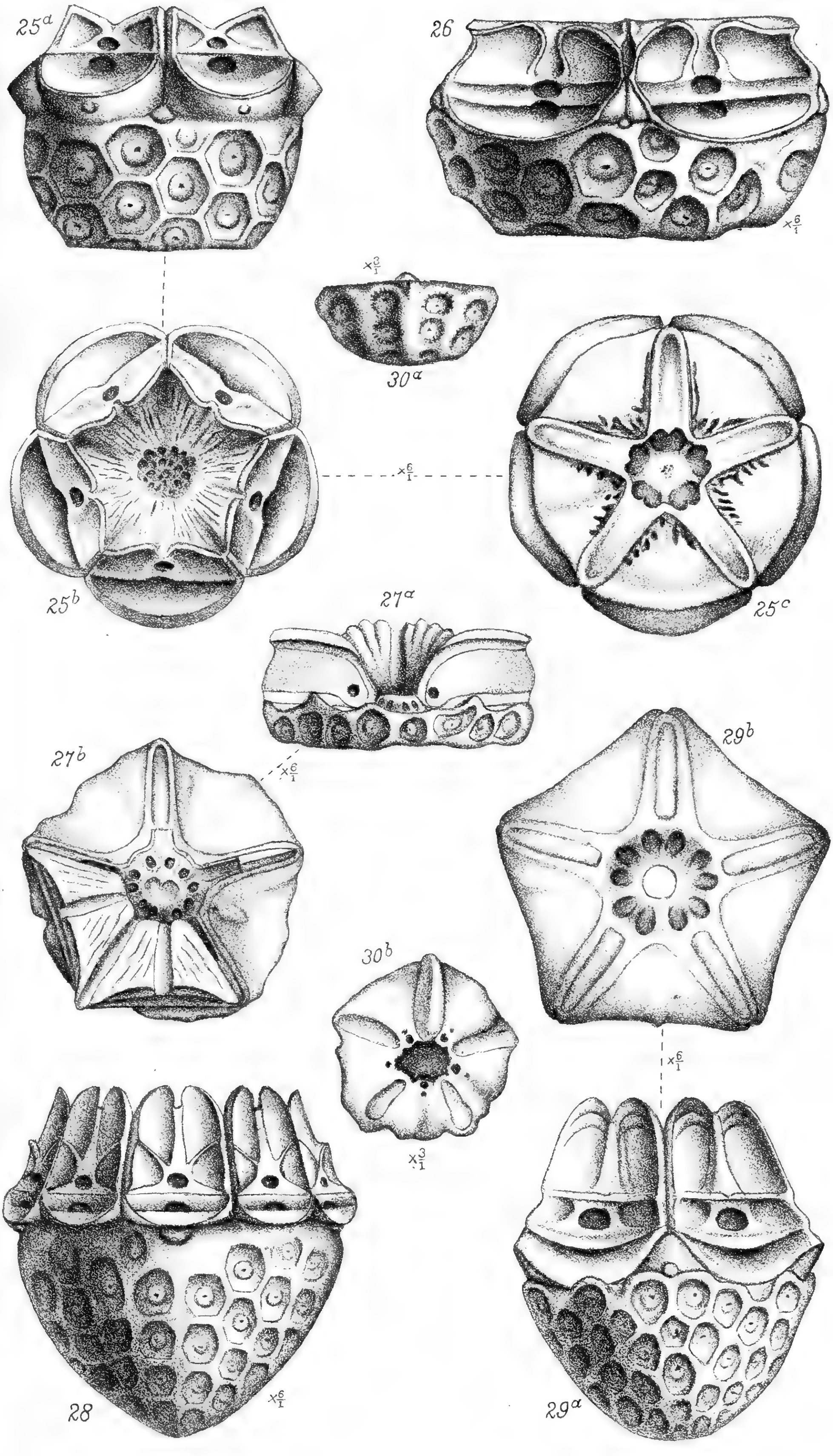
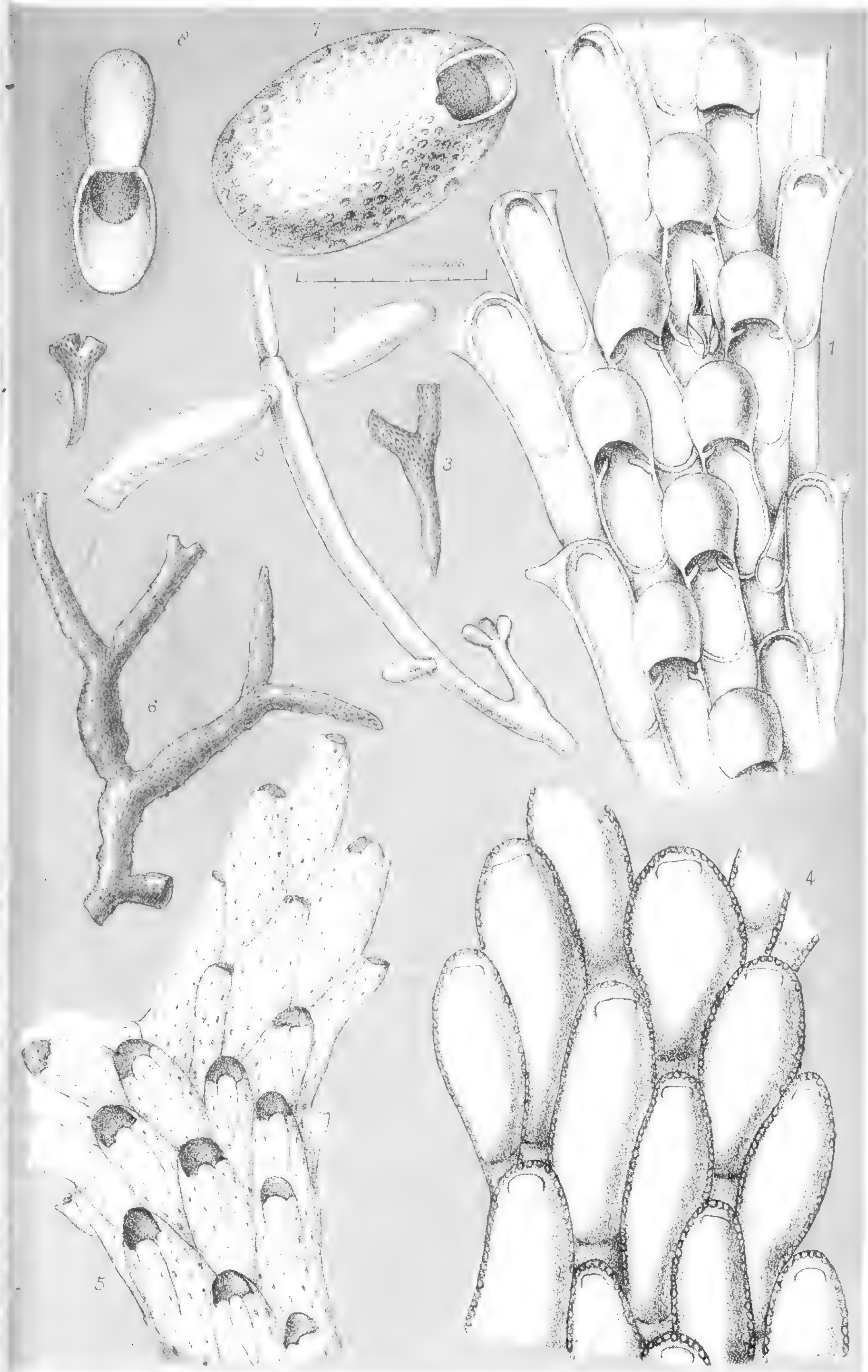
SPECIES OF ANTEDON, ACTINOMETRA, & PENTACRINUS.

Hanhart imp.



Berjeau lith. "CHALLENGER" SPECIES OF ANTEDON, ACTINOMETRA, & PROMACHOCRINUS. Hanhart imp.



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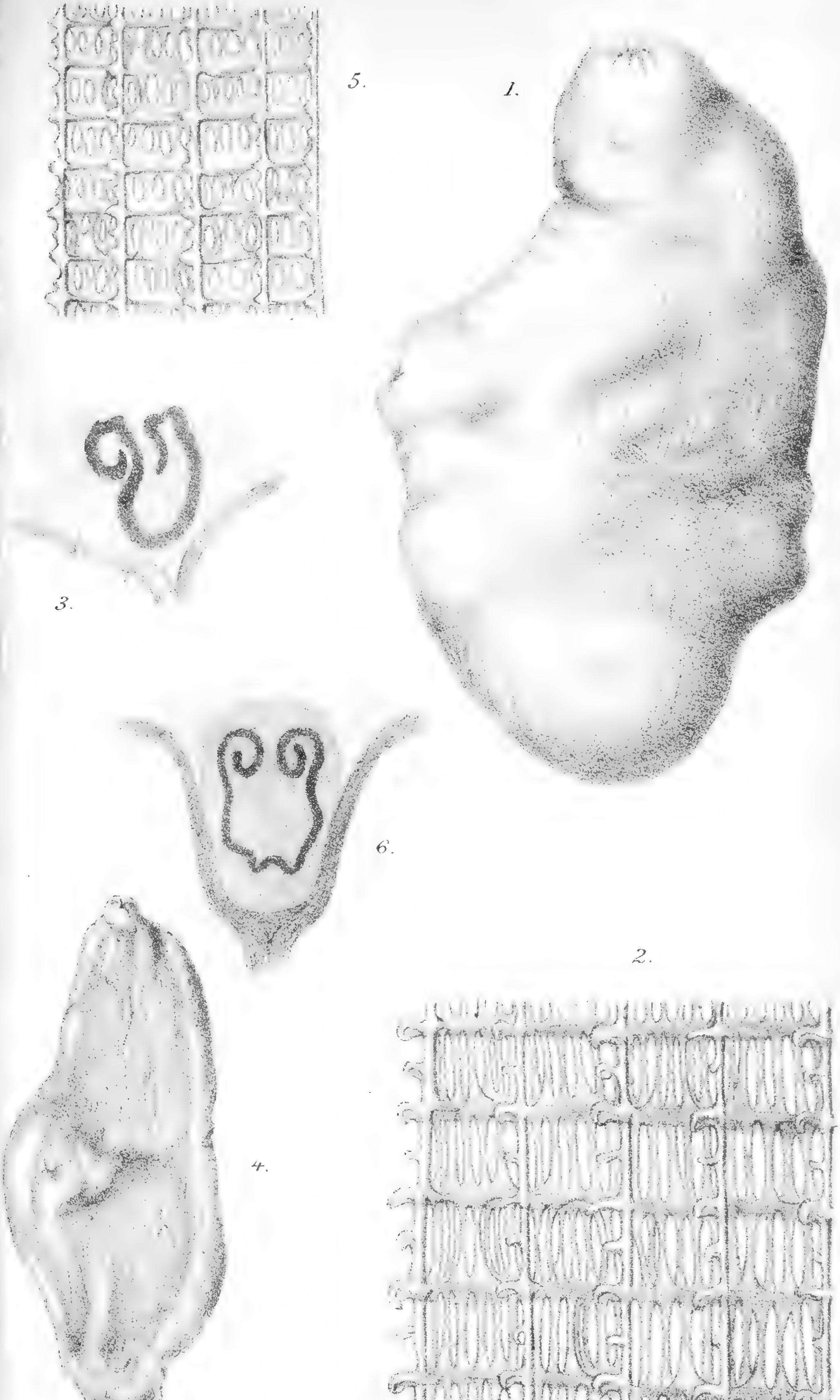
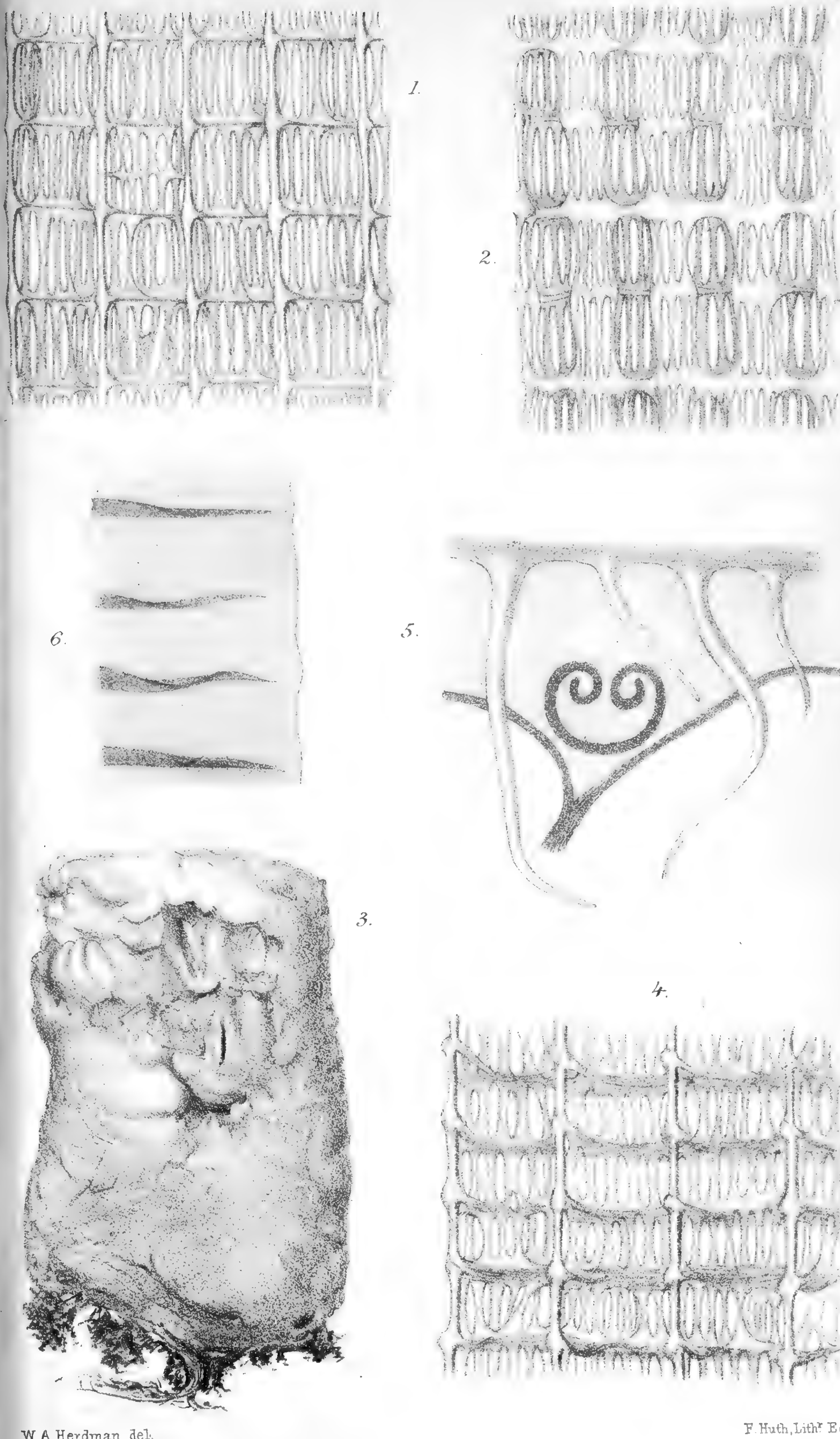
NEW ARCTIC POLYZOA.



W. A. Herdman del. F. Huth, Lith^{r} Edin^{r}

1-3. ASCIDIA LATA. n. sp. 4-6. A. FUSIFORMIS. n. sp.



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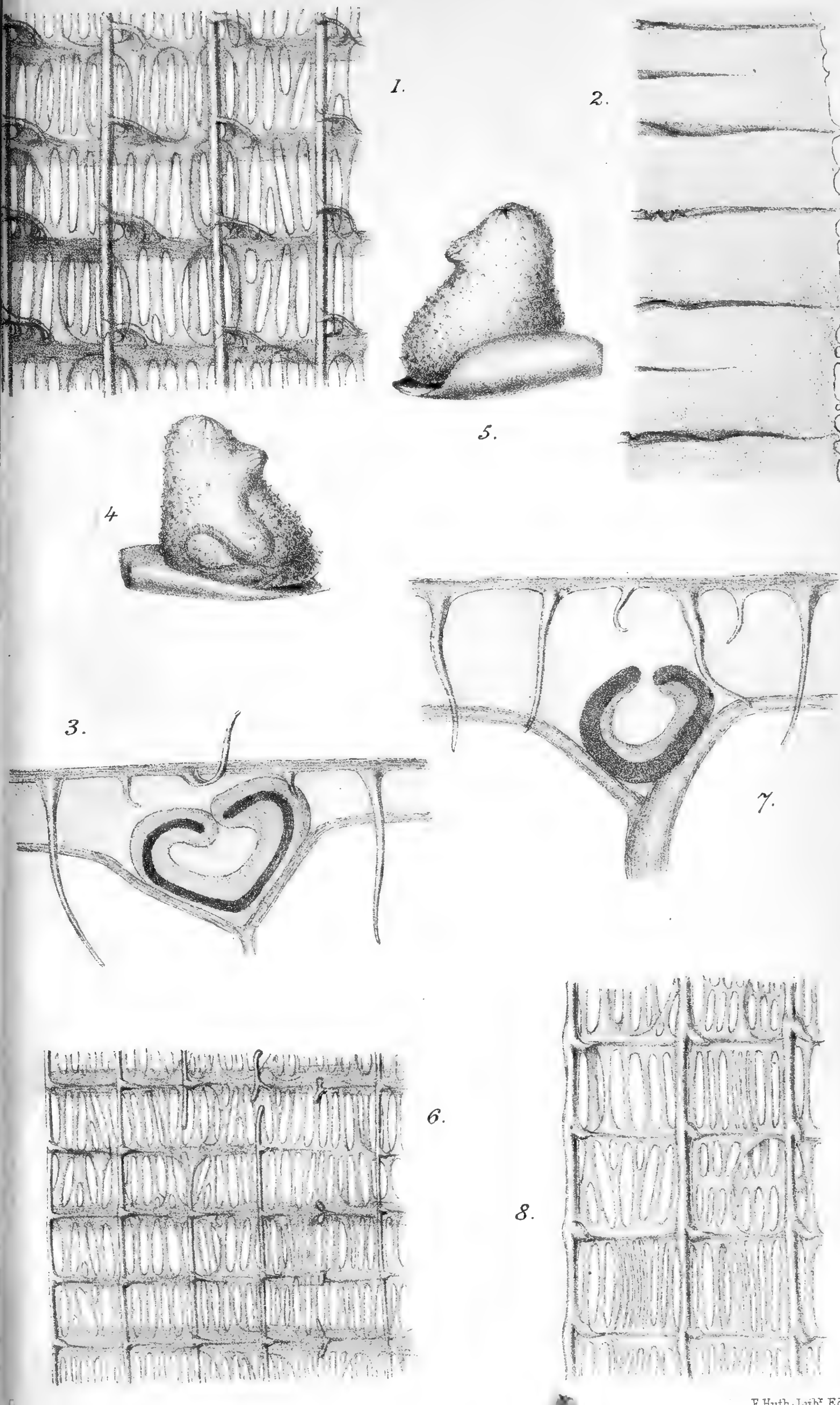
1-2. ASCIDIA VIRGINEA. O.F. Müller.: 3-6. A. TRUNCATA. n. sp.



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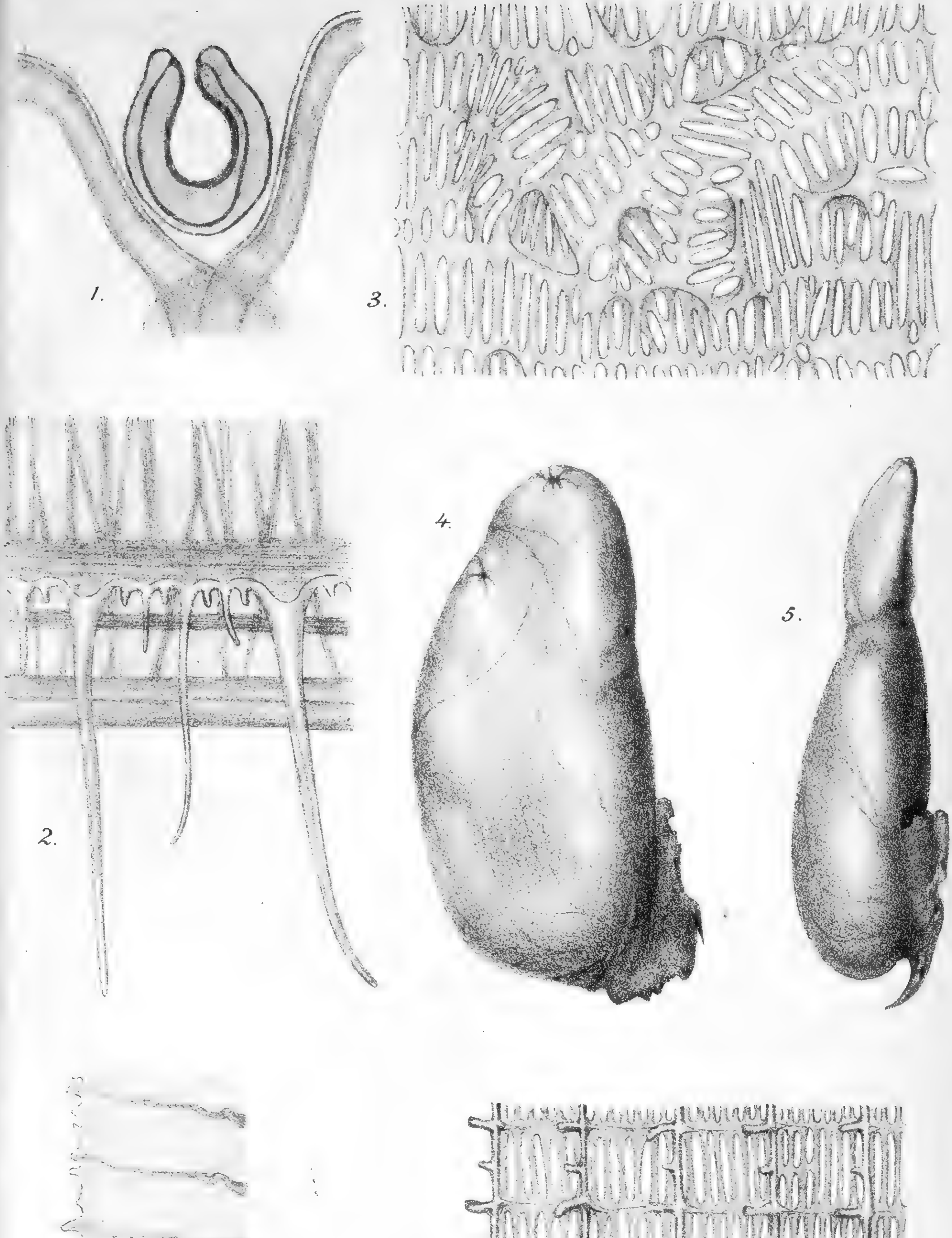
F. Huth, Lith[r] Edin[r]

I-3 ASCIDIA ASPERSA. O.F. Müller.
4-7. A. TRIANGULARIS n. sp. 8. A. SCABRA. O.F. Müller.



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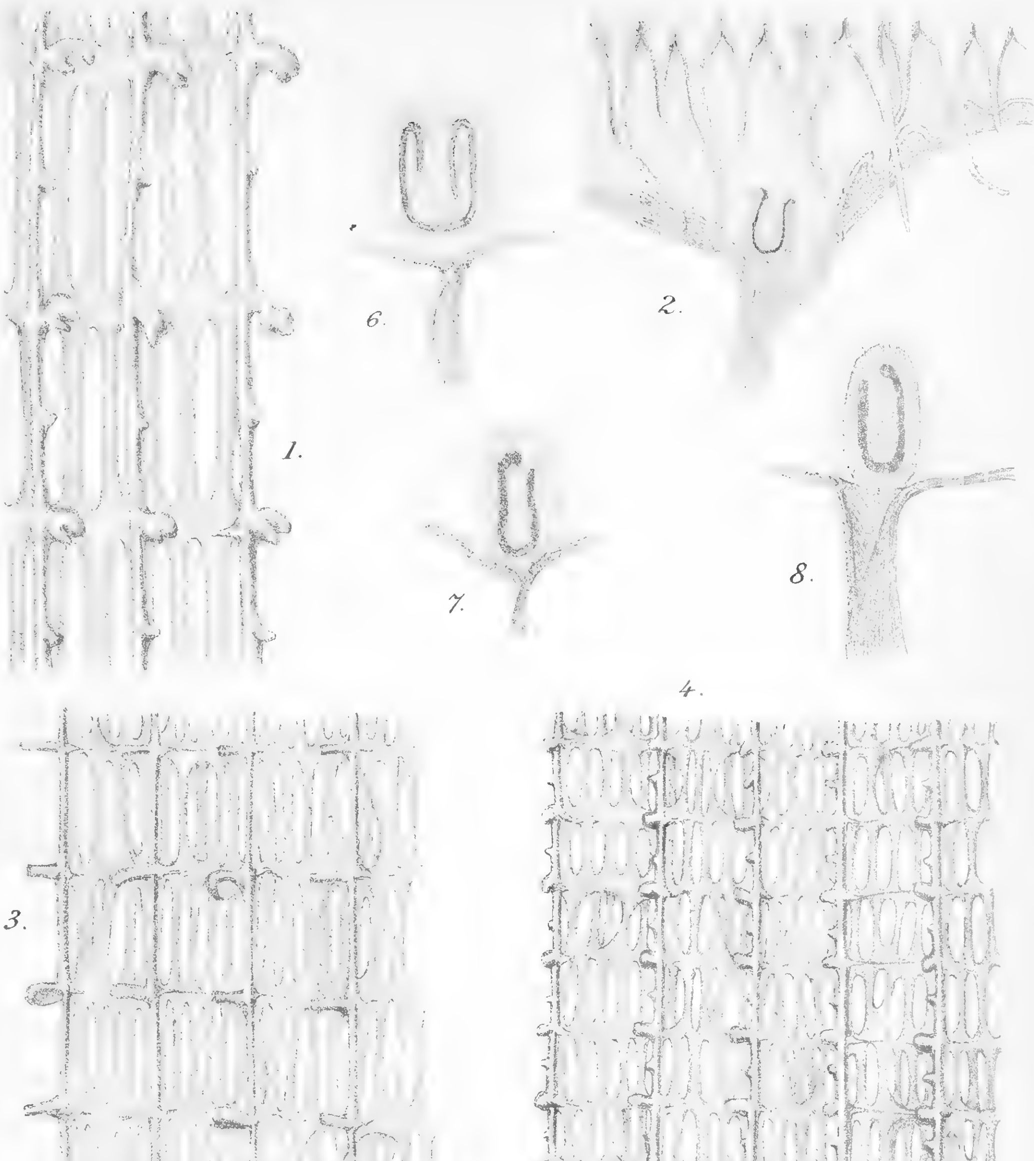
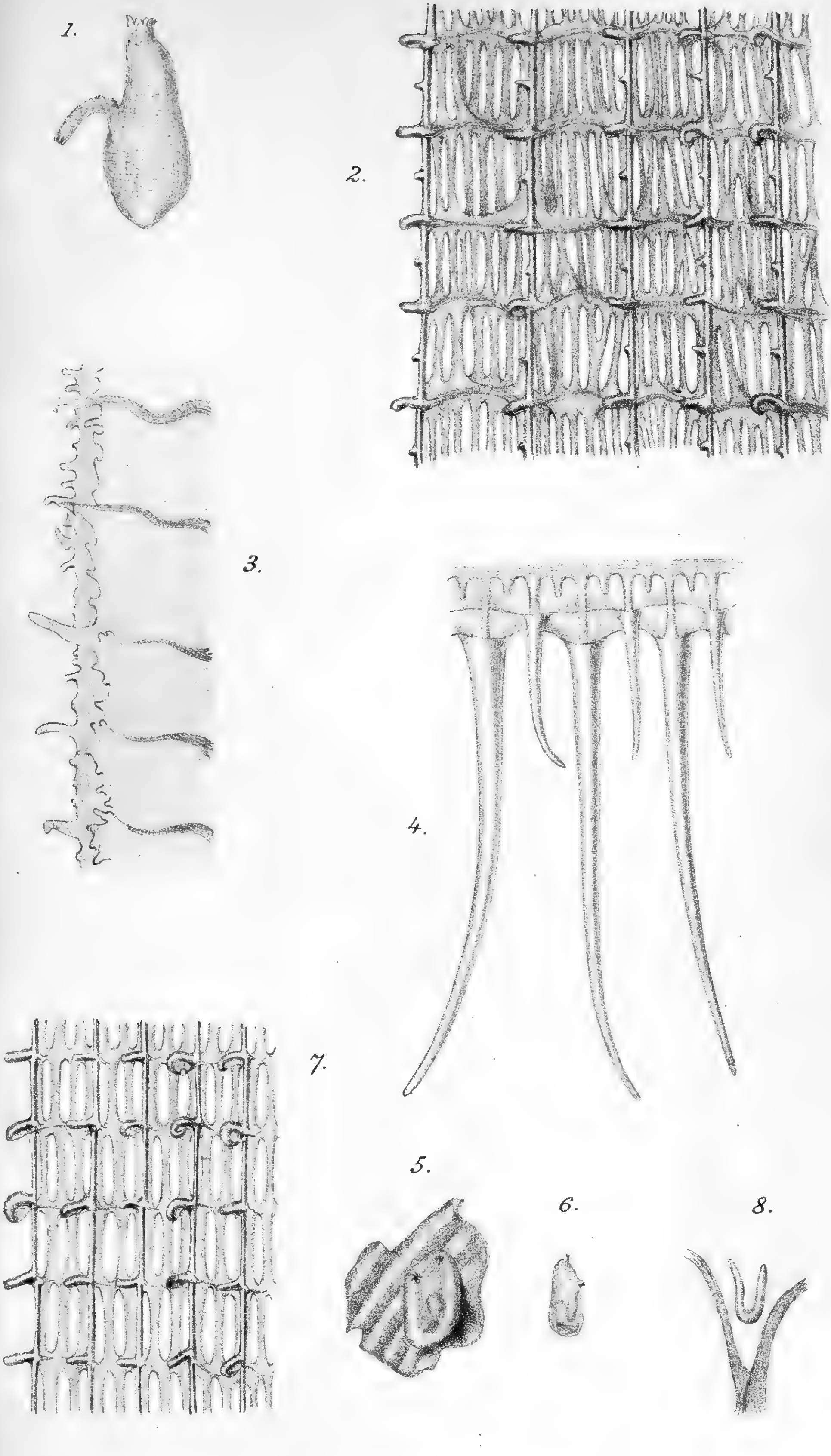
1-3. ASCIDIA SCABRA. O.F. Müller. 4-7. A. PATONI. n. sp.



W. A. Herdman del.

F. Huth, Lith. Edin.

1-2. ASCIDIA MURICATA, Heller: 3. A. OBLIQUA. Alder.
4-5. A. DEPRESSA. Alder: 6-8. A. PLEBEIA. Alder.



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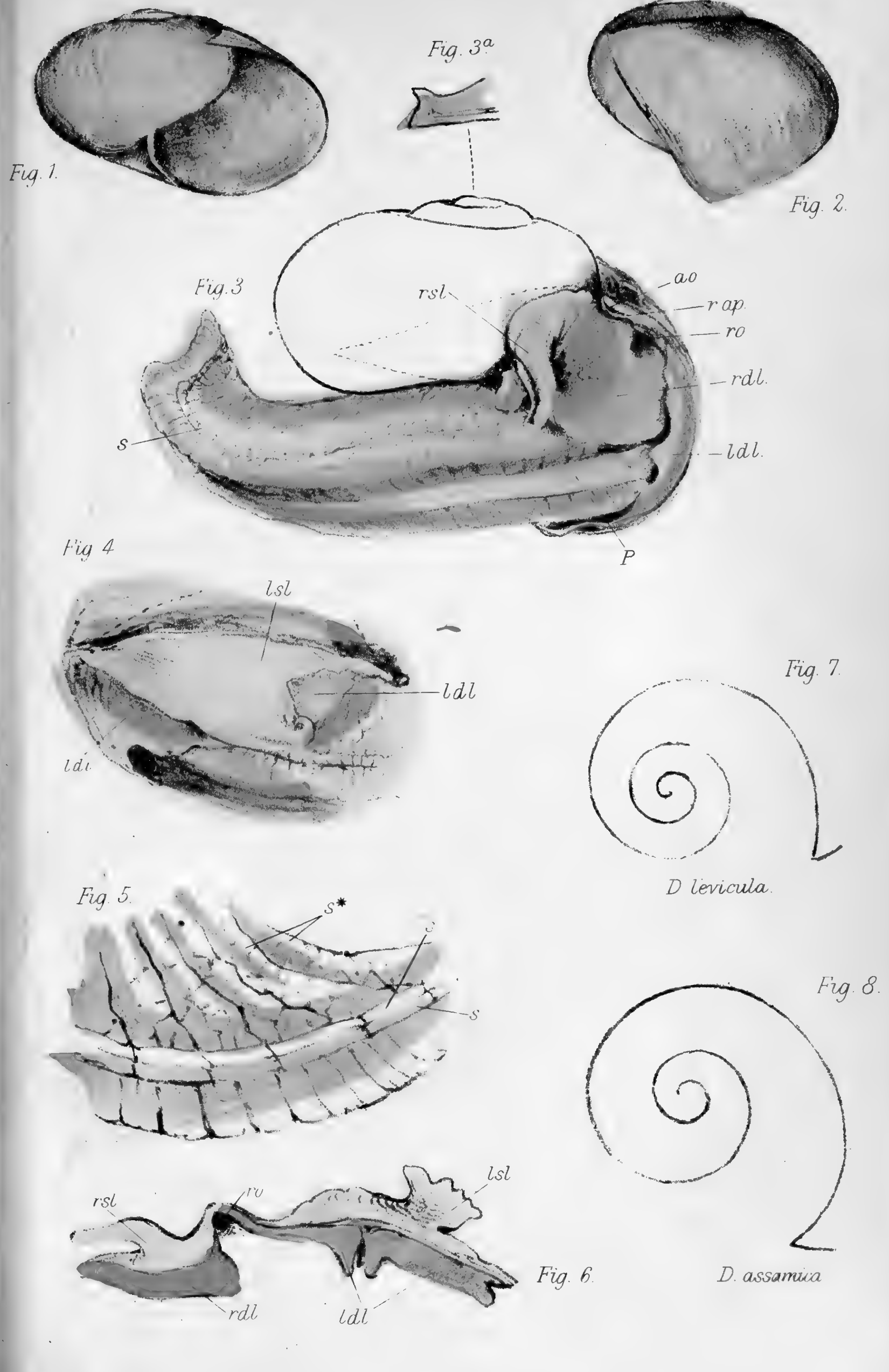
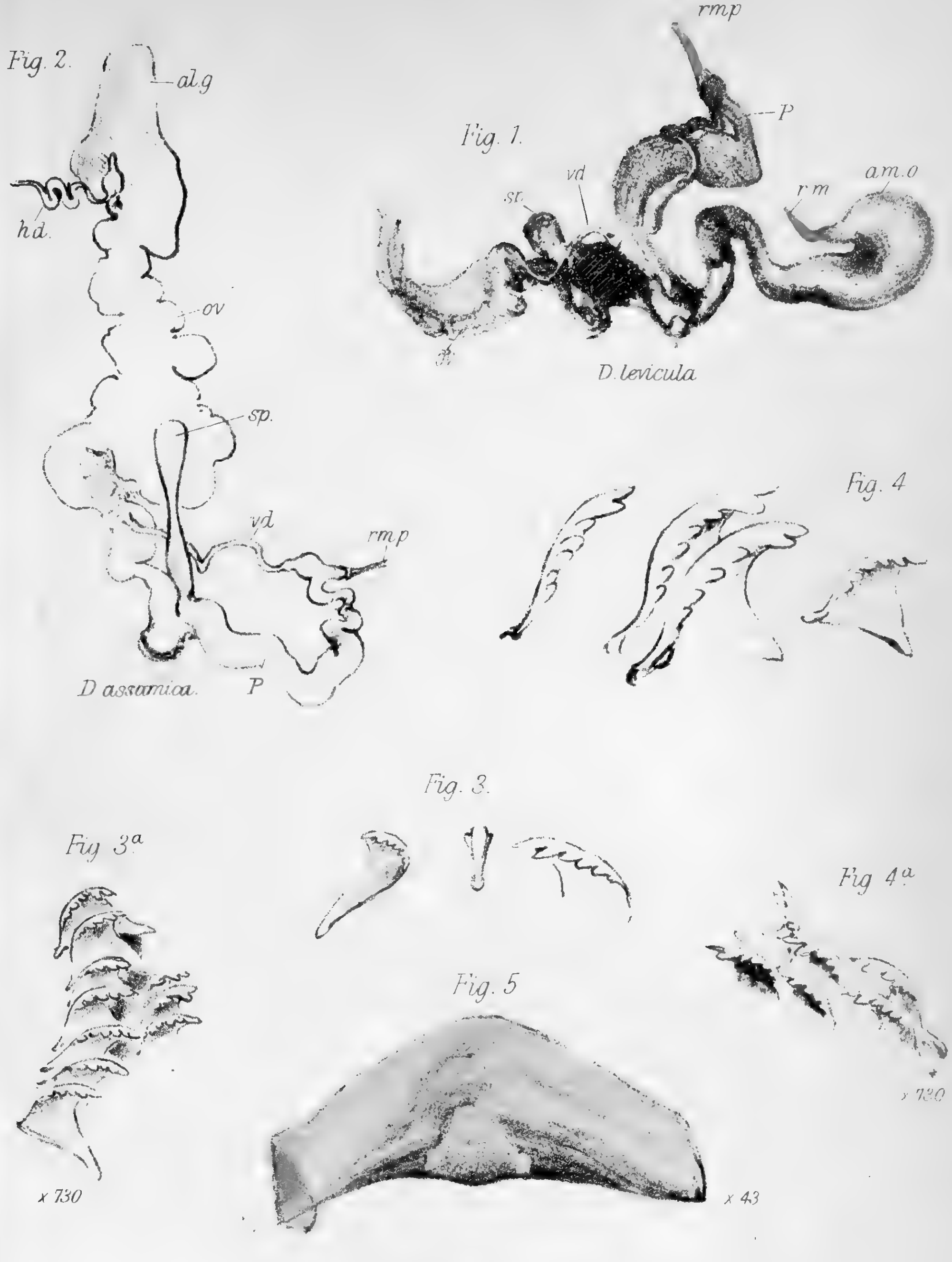
F. Huth, Lith^{r} Edin^{r}

1-4. ASCIDIA PLEBEIA Alder: 5-8. A. EXIGUA. n. sp.



DURGELLA.

H. H. Godwin-Austen, lith.
Maclure & Macdonald, imp.



H. H. Godwin-Austen, lith.

DURGELLA.

Maclure & Macdonald, imp.

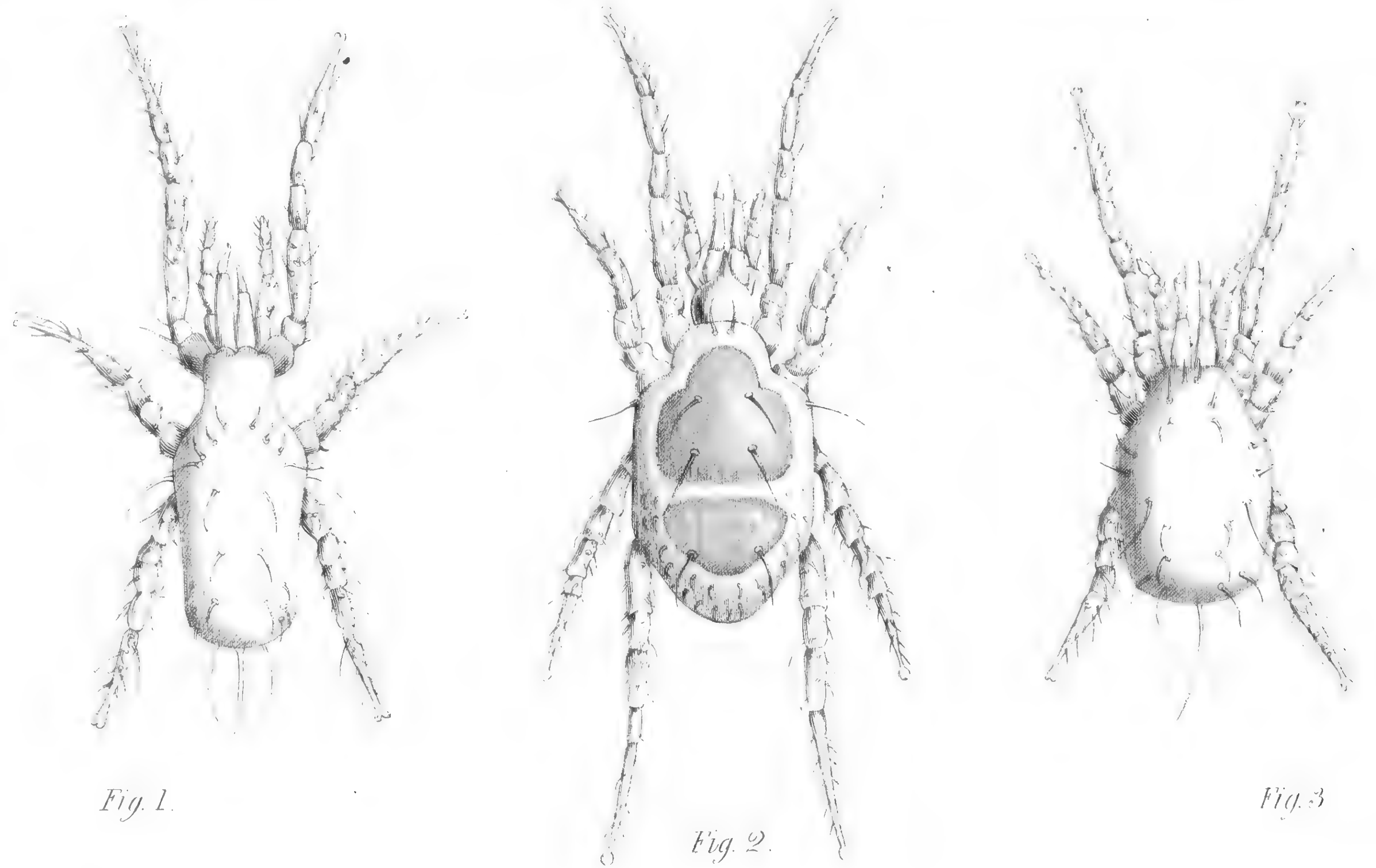
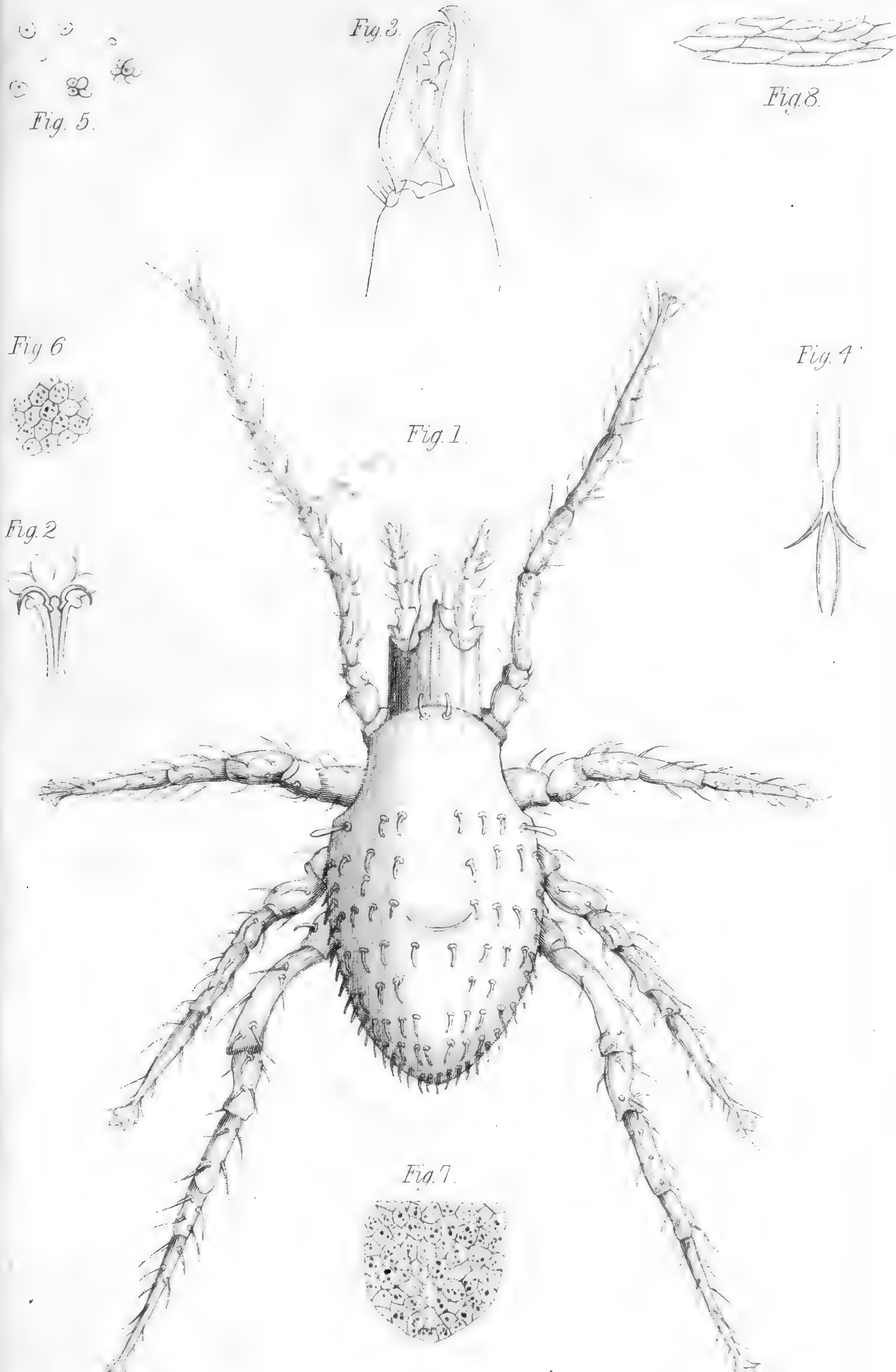


Fig. 1. Fig. 2. Fig. 3

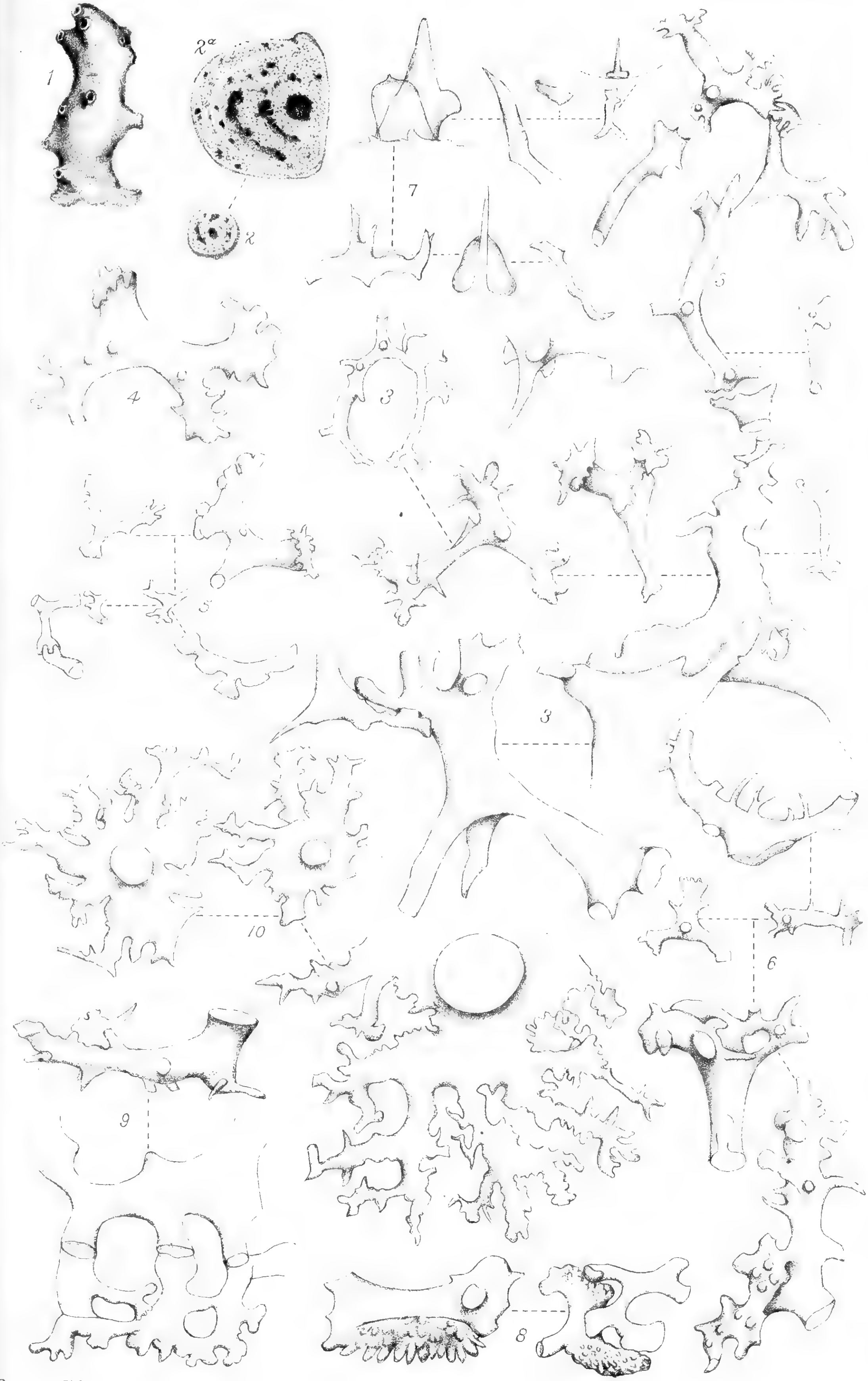
A.D. Michael del. G. Jarman sc.

1-2 *Larva & Nymph*, GAMASUS COLEOPTRATORUM; 3 *Larva*, G. CRASSIPES.



A.D. Michael del. G. Jarman sc.

1-3 & 8. GAMASUS COLEOPTRATORUM: 4-7 G. CRASSIPES.



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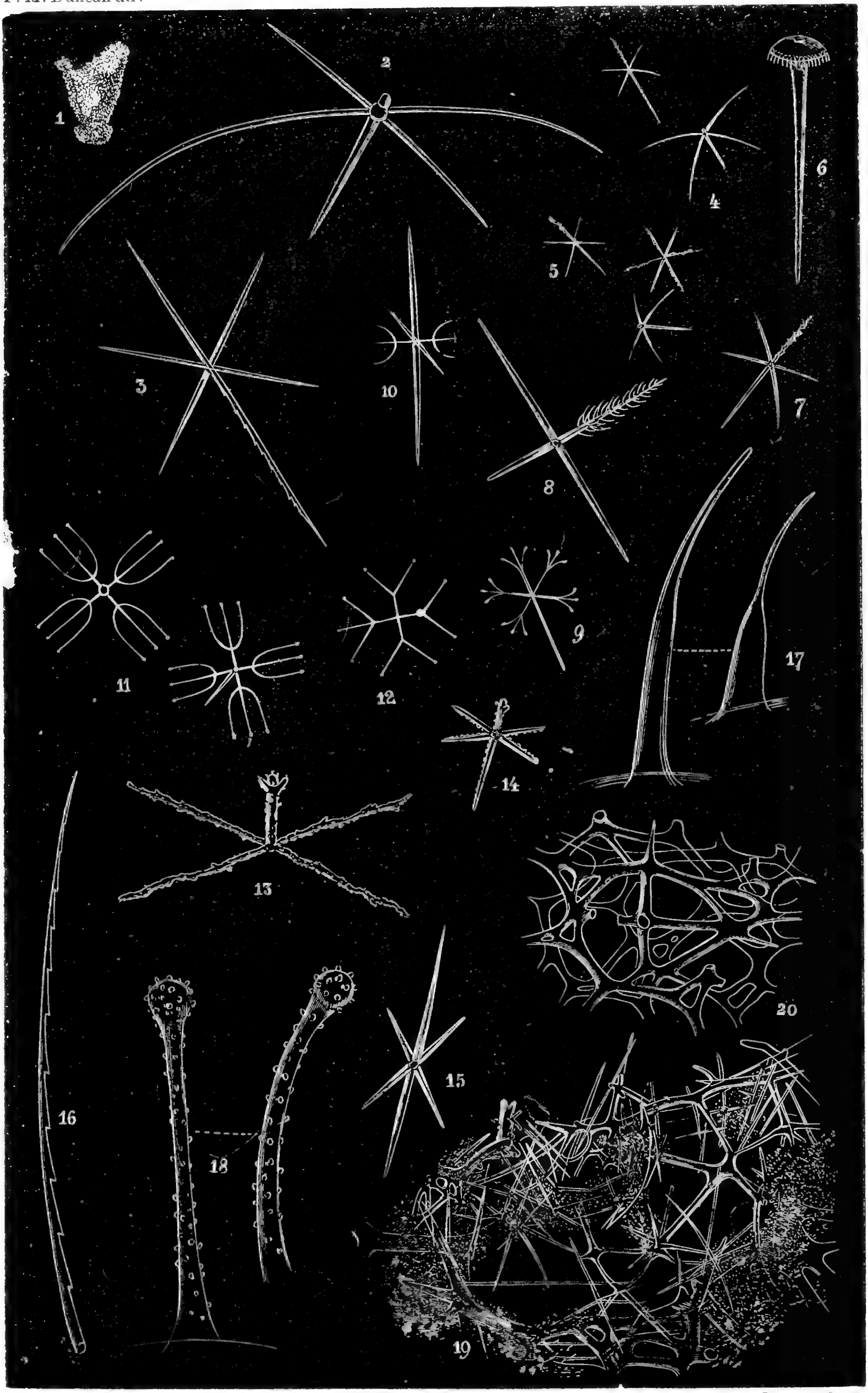
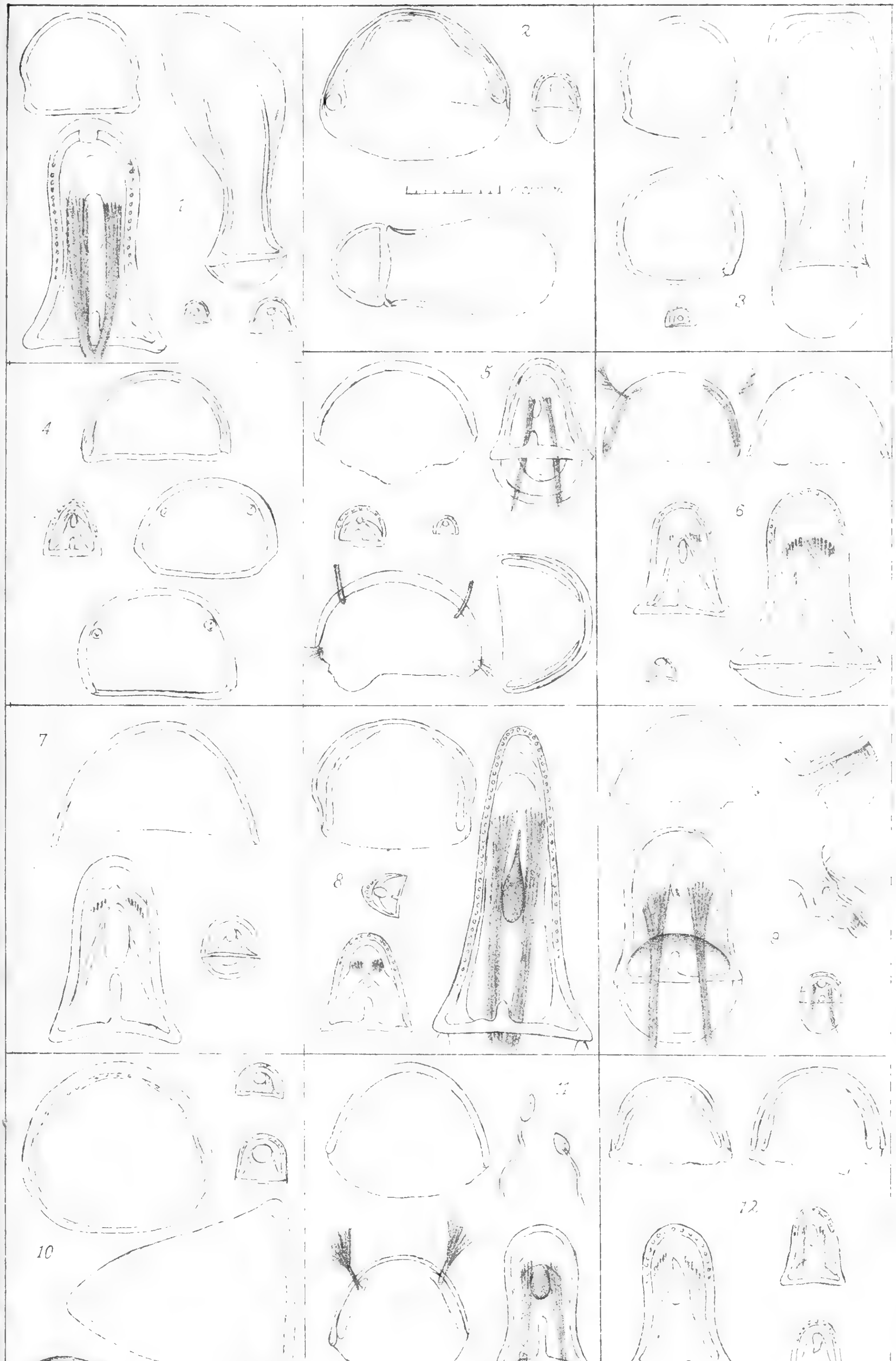
Hanhart imp.

LITHISTID SPONGE & SPICULA.



Berjeau del. Ferrier fecit.

APHROCALLISTES SPECIES? AND SPICULA.



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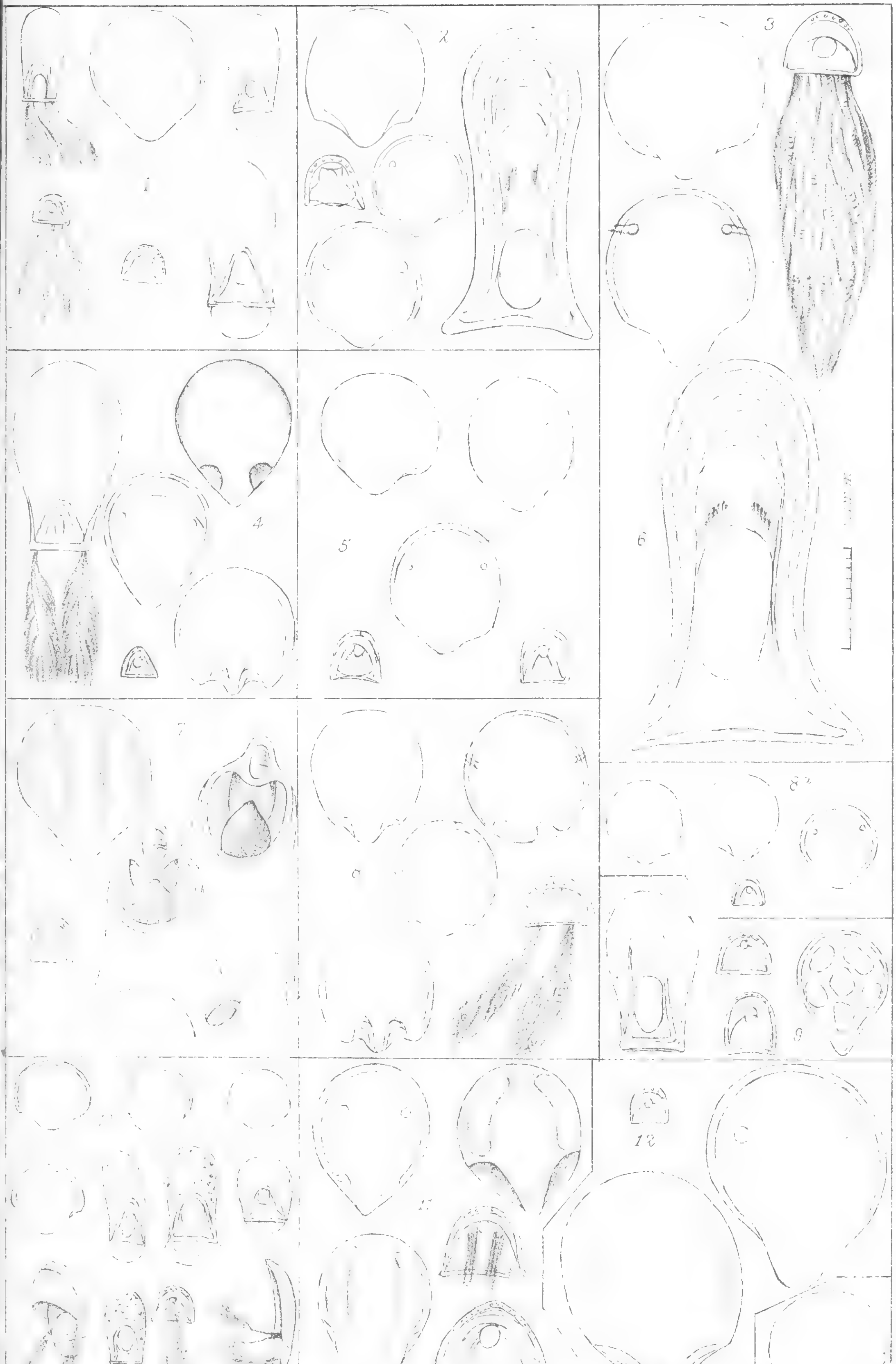
CHITINOUS APPENDAGES SPECIES OF CELLEPORA.



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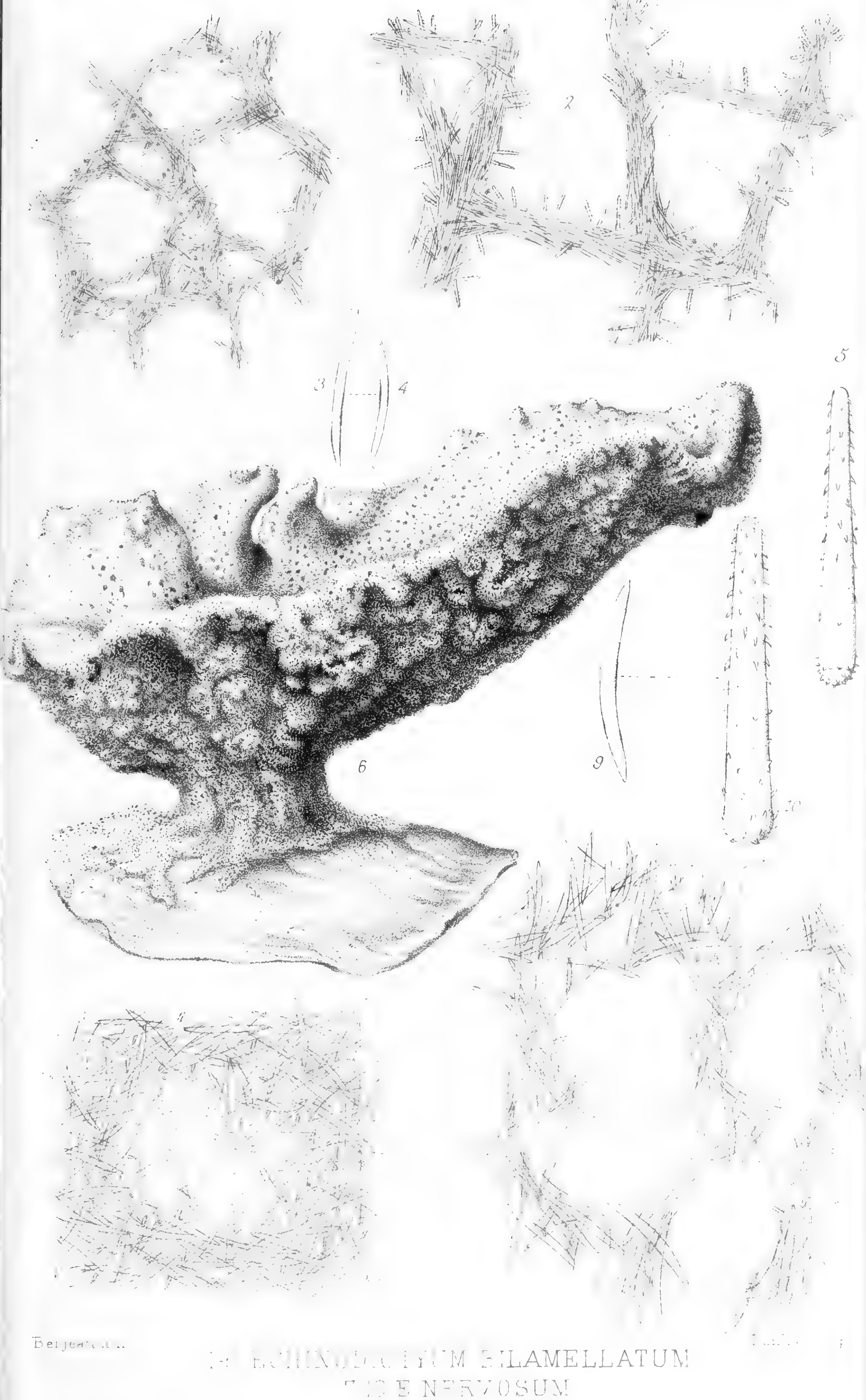
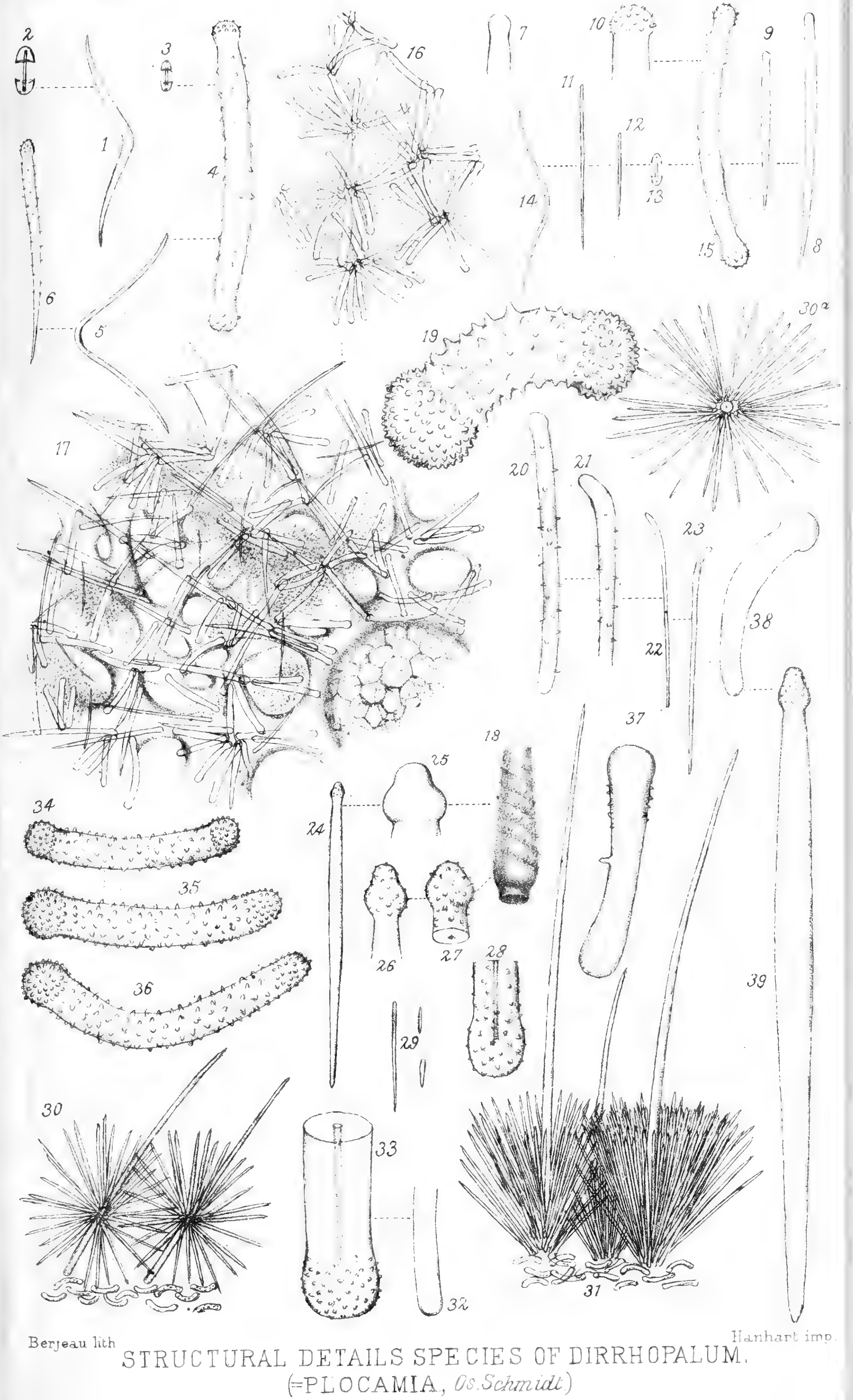
CHITINOUS APPENDAGES SPECIES OF CHL



Berjeau lith.

1-5. ECHINODICTYUM BILAMELLATUM
6-10. E. NERVOSUM

Duncan & Ridley



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STRUCTURAL DETAILS SPECIES OF DIRRHOPALUM.
(=PLOCAMIA, *Os. Schmidt*)

MARCH 30. 4892, March. 14. 1881 Price 3s.

THE JOURNAL

OF

THE LINNEAN SOCIETY.

VOL. XV. **ZOOLOGY.** No. 81.

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Correction of Error in the previous Number (80) *of Journal, Zoology, and omitted in the Errata at the end of the Volume* (xiv.).

Page 735, fourth line from bottom, for "*figurinensis*" read "*tigurinensis.*"

ANNIVERSARY MEETING.

This takes place on Monday, 24th May, at 3 p.m., when the President will deliver his Annual Address, and the Officers and Council be elected. Fellows are respectfully invited to attend.

The usual Meetings for Scientific business of the current Session, on Thursday evenings at 8 p.m., are as follows:—

April 1st,	May 6th,	June 17th.
„ 15th,	June 3rd,	

Intimation of Communications intended to be read on any of these nights ought to be forwarded early; for inconvenience arises from too many papers being crowded into the final Meetings, occasionally to the disappointment of authors.

TRANSACTIONS (New Series).

There have been issued for 1879–80, and can be had by the Fellows on application or forwarded by order (carriage being paid by the Fellow), the subjoined four parts:—

Zoology, vol. i. part 8, and vol. ii. part 1. Botany, vol. i. parts 6 and 7.
Another part of Zoology and one of Botany are now in the press.

JULY 31. 4892 March, 14, 1881 Price 3s.

THE JOURNAL
OF
THE LINNEAN SOCIETY.

VOL. XV. **ZOOLOGY.** No. 82.

CONTENTS.

Erratum in p. 78, Prof. DUNCAN's description of Pl. III.: fig. 4 should read fig. 4, *a*, *b*, *c*; and fig. 5, *a*, *b*, *c*, should read fig. 5.

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The Council meet once a fortnight during the Session, namely, on the same Thursdays as the General (Scientific) Meetings (*infrà*), but at 4 P.M.

LIBRARY COMMITTEE.

This consists of nine Fellows (three of whom retire annually) and of the four officers *ex officio*, in all thirteen members. The former are elected annually by the Council in June, and serve till the succeeding Anniversary. The Committee meet at 4 P.M., usually once a month. The Members for 1880–81, in addition to the officers, are:—

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George Busk, F.R.S.
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TO BE HELD AT BURLINGTON HOUSE, SESSION 1880–81.

On Thursday Evenings, as undermentioned, the Chair being taken at 8 P.M.

1880. November	4	1881. February	3	1881. April	21
„	18	„	17	May	5
December	2	March	3	June	2
„	16	„	17	„	16
1881. January	20	April	7		

The Anniversary Meeting takes place on TUESDAY, 24th MAY, 1881, at 3 P.M.

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VOL. XV. **ZOOLOGY.** No. 83.

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1880.

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THE JOURNAL

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VOL. XV. **ZOOLOGY.** No. 84.

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Errata. In Sir J. LUBBOCK's paper in Journal No. 83, p. 186, top line, *for* "incredible" *read* "inevitable;" and after "Australiam" in same page, line 15 from top, the note of interrogation to be discarded.

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